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July 29, 1926

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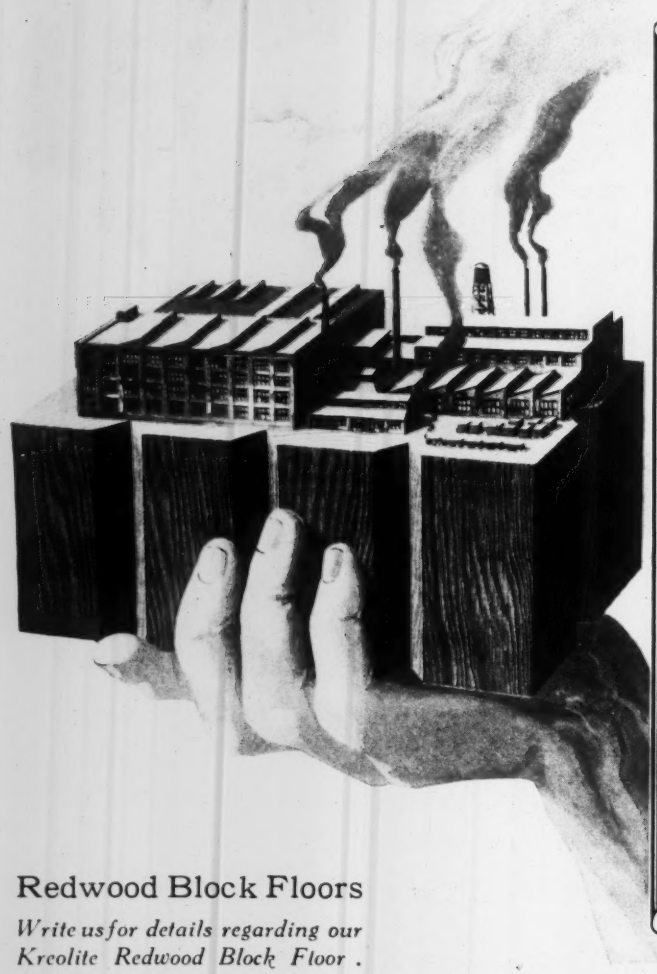

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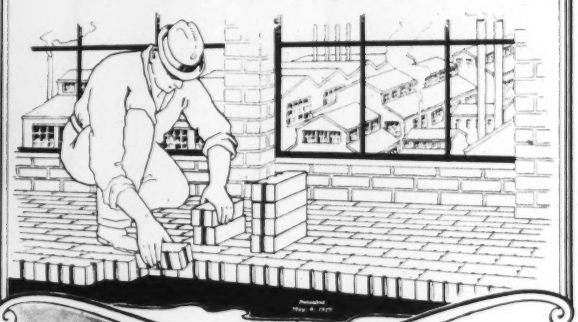

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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FRANK C. WIGHT
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Roebling Passes Away

ANOTHER of the great figures in the history of American engineering passes from the scene with the death of Washington Roebling. Builder of the Brooklyn Bridge—a position which he shared in full right with his father, John A. Roebling—he crystallized into definite being an art that prior to his time had been at best half-formed, and in doing so he created a model by which numerous other great bridges were proportioned and judged. The work was the accomplishment of genius rather than of science, though science contributed fully; best evidence of that genius is the fact that throughout its fifty years of history the Brooklyn Bridge occupied a place of its own. Universal appreciation was accorded its beauty and grace, and today quite as much as when first completed it draws and charms the beholder's eye. It is one of life's strange coincidences that Roebling should die but a few days after the opening of the Delaware River bridge, successor to his own creation as a milestone of history in suspension bridge construction. The structure of the 80's and the structure of the 1920's each typifies the excellence of its contemporary industrial and constructive art, and we may get a juster appreciation of the great work which the Roeblings, father and son, accomplished, when we observe that the bridge of 1926 exceeds theirs by only one-sixth in length of span—though in the time that has elapsed there was shaped and developed the entire mighty structure of modern industry.

An Empire Builder

ONE of the greatest of those who created the marvelous industrial structure of today also has just left us. Charles A. Coffin, builder of the General Electric Company, will live long in the history of business growth as the organizing genius who shaped one of the giant structures of manufacturing activity in the world's history. His achievement may seem the result of special opportunity, for he labored in a field of magic growth. Within his time the electrical art developed from the earliest days of the street-corner arc light and the pioneer trolley car to its present overshadowing position with almost startling rapidity. But for this very reason he may be entitled to higher appreciation, since it needs rare qualities indeed to see clearly and guide surely amid such turbulent developments. And when other great corporate industrial creations are brought into comparison, we have to remember that electrical development was not assisted by the aggregative tendency of natural monopoly, and that its increase came by growth rather than by merging and combining that which already existed. It was a creative force. Coffin guided a large part of that development. And though his work bore on the organizational rather than the technical side, it is yet noteworthy that his forethought created the favorable opportunity for development of the technical side. Moreover, he was wise enough to choose as his own successors men who would carry on his own work with equal breadth of vision and with equal understanding of the basic dependence of modern industry upon engineering and scientific progress. He was fully as remarkable as his technical collaborator Steinmetz, who preceded him in death only by a short time; and Coffin will hold an equally distinguished place in our electrical history.

Paving Advance

DEVELOPMENT with the years of strength requirements in pavement construction is sharply presented in the account in this issue of the three pavings of Lindell Boulevard, one of the display thoroughfares of St. Louis. Forty years ago macadam on telford, the original pavement, was a high type. The bituminous concrete which replaced the macadam after 19 years was an advance in strength and resistance. The new pavement of this year introduces a rigid base of concrete, with a bituminous concrete surfacing, one of the best of the modern road types. Thus the street has kept up with the progress in pavement engineering. It is more significant, however, that in the case of each of older pavements, its disuse and renewal were dictated by others reasons than service failure. On any street where less perfection of surface was demanded either of the old pavements would have been held, at the time of its reconstruction, as satisfactory for some period of additional use. The greatest lesson is that fundamental structure is never a lost investment however many times the surface of a road may require renewal. The old telford and much of the old macadam with which Lindell Boulevard was paved in 1886, forms the tried and sturdy foundation which makes the pavement of 1926 one of the most advanced among pavement structures of recent years.

Decrease in Transverse Fissures

THAT rail failures due to transverse fissures will gradually cease to trouble the railway engineer, and that this desirable course is due to improvements in rail-mill practices, are gratifying conclusions of a report issued by the rail committee of the American Railway Engineering Association. That the fissures result from defects which are produced in manufacture and are then developed by the stresses incident to traffic, are other conclusions, in which a specially important point is that transverse fissure failures occur under both light and heavy wheel loads, but more slowly in the former case, as is to be expected. All these points, directly controvert the position held persistently by the Bureau of Safety of the Interstate Commerce Commission to the effect that manufacturing conditions have nothing to do with transverse fissures in rails, but that these fissures are due entirely to heavy wheel loads. A mass

of evidence supports the committee's findings. It is particularly encouraging to note that rail failures in general, including those due to transverse fissures, are decreasing as a result of improvements in manufacture, and that the transverse-fissure failure will gradually cease to be an important source of trouble.

Large Contracts

LARGE contracts are measured by quite a different standard now than they were in the days before financing a world war made a million dollars small change in a nation's expenditures. Perhaps this figure, $1,000,000, is as logical as any with which to start the count of large contracts. On that assumption our business news department record of contracts let since Jan. 1, 1926, presents over 80 which amount to a million dollars, with a range from $1,000,000 to $52,000,000 and an average over $4,000,000. The significance of the recapitulation does not lie in the precision of the enumeration but rather in the broad demonstration that in the contracting business today a million-dollar transaction is common and a contract is not large until it passes the $4,000,000 mark. The magnitude of these big transactions must not lead one to assume that altogether they represent a large percentage of the total construction business. It is the aggregation of contracts averaging less than a million dollars and the sum of the contractors who perform these monetarily less spectacular operations which form the height and bulk of the contracting business body of America. Their's is the work which will stamp as faulty or successful the contractor's place in engineering construction. Their's is the great task of justifying the contractor by superior technique and sound integrity of construction. How far is the association work of contractors carrying help and example to them?

Colorful

BLACK shirts and tricolor sashes made colorful the displacement on July 20 of elected councils in Lombardy by podestas or governors appointed in Rome. Whether for the sake of economy or impressiveness these imperial governors of some 240 Lombardian towns of under 8,000 populations were inaugurated en masse in Milan, according to a dispatch to the New York *Evening Post*. The official reason for this abolition of representative government, as given some months ago when the change was determined on by Mussolini, was that the elected councils were composed of mediocre men and that the towns would be far more ably administered by single officials for each, chosen for ability. The outcome of the change, like that of many other acts of Italy's dictator, will be awaited with interest.

Baltimore Sewage-Works Results

FEW sewage-works can show such extensive operating records for so many years as those of Baltimore, Md. The summary tables and curves reported and discussed elsewhere in this issue cover fourteen years for many of the data and supplement earlier articles on the same general subject. Since 1912, the average daily volume of sewage treated has increased from 11.8 to 55 m.g.d., the respective contributing population being 50,000 and 673,000. Unit volume operating costs, naturally high when the works were running far below capacity, decreased from $4.86 to $2.60 per m.g.d. from 1912 to 1916, then mounted to the maximum of $6.62 in 1922, since which there has been a slight decline. The highest per capita cost of operation since approximately the present volume of sewage was treated has ranged from 11.52c. in 1918 to 20.99c. in 1922 since which maximum the cost has fallen to 16.98c. per capita in 1925. These are but a few of the many lines of data given in our latest and current article on one of the largest and most interesting sewage-works of the world, which like the plant at Birmingham, England, is notable for the large-scale use of separate sludge digestion.

Capital Outlay Budgets

CONFRONTED with an immense state debt already contracted and legislative authorizations for large additions within the next ten years, the Special Joint Committee on Taxation and Retrenchment of New York State has made several commendable recommendations. Among them are proposals for capital budgets and for a gradual change to a pay-as-you-go policy for annual recurring capital outlays, reserving bond issues for emergency purposes. These proposals deserve attention with a view to possible adoption in every state of the Union. The capital budget proposed by the committee would be an integral part of the general budget system of the state, but the capital budget would be framed for a term of years instead of for a single year. We have urged in these columns more than once that our municipalities should work to a program covering say five to ten years. A few of them are now doing so. The vast increase in state expenditures of late makes it equally important that state programs be adopted. A like plan should be applied to Federal expenditures also. The plans for all three classes of government expenditures should include current or operating expenditures and receipts as well as capital outlays and the ways of meeting them. This would naturally come from the recommendation already cited to correlate the five- or ten-year capital budget with the budget for current expenditures, and the need for it would increase with the growing use of the pay-as-you-go plan.

Feelers

FROM the cool green shores of Lake Champlain the chief financial officer of New York State broke into his vacation long enough to utter some winged words that caused a passing breeze of comment when they reached New York. These were comments on how New York City's immense subway construction program is to be financed, especially if five-cent fares are to be continued. Fare increases were not advocated but attention was called to the need of a well-devised plan to meet existing large subway deficits and coming larger ones attributed to the nickel fare. Presumably this was a feeler, to try out public opinion. Before comment on this matter has quited down the time seemed to someone opportune for a feeler on water meters. Accordingly a suggestion appeared that the water supply of New York City should be metered, both as a matter of controlling waste and of a just distribution of the capital and operating expenses. Here also, the need for huge additional outlays to meet rapidly growing service demands was stressed. In both cases the homely doctrine that the dancers should pay the fiddlers was urged. Doc-

trine like this needs to be brought home in these days of mounting debt and taxation, especially for services like transit and water which, under proper financing, can be entirely self-supporting without being burdensome on individuals or families.

Procrastination With Hopes for Progress

MORE procrastination on adopting a state water policy was the main result of the adjourned session of the New Jersey Legislature that met June 22 and recessed on July 20 to meet after the state elections are over and the new party balance has been struck. This was to be expected in view of the public apathy, conflicting interests and political maneuvering noted on p. 3 of our issue of July 1.

The only outstanding action on the water problem was the passage of a joint resolution initiating a constitutional amendment, and that is subject to revision or nullification by the 1927 legislature. Even a second adoption of the resolution settles nothing, since it must be followed by a referendum vote. Aside from the proposed constitutional amendment, the legislature did nothing on the water problem except to give hearings and pass four minor bills. One of the bills is wholly political. The others merely increase the powers and funds of the existing Water Policy Commission.

Failure of the Water Policy Commission to submit a definite program of legislative action, accompanied by drafts of bills, may partly account for the further procrastination of the legislature in this matter. Of the various recommendations of the commission the only ones accepted by the legislature were those advising further study of the proposed Tri-State Delaware River compact, separate studies of New York-New Jersey water problems, and one small part of a series of proposals relating to the existing water district legislation, the latter merely requiring Senate approval to the Governor's appointments of commissioners.

The proposed constitutional amendment is at variance with some of the recommendations of the commission as to water supply districts. It is more constructive and far sounder in principle than the various proposals for statutory action which the commission submitted.

If the legislature had not continued the Water Policy Commission in office last winter and given it additional power and money at the adjourned session, there would be reason for thinking that the report of the commission had fallen flat. As it is, a more hopeful view is warranted. "Referred back for further study and material revision" may be accepted as the legislative verdict on the commission's report.

Particularly commendable are the underlying principles of the legislature's plan for water supply, sewerage, drainage and meadow reclamation districts, embodied in the proposed constitutional amendment; that is, that the districts shall be governmental units with powers of financing themselves, independent of the state on the one hand or the individual municipalities to be served on the other. Had such an amendment been proposed and adopted fifty years ago many a water and sewerage tangle in New Jersey might have been averted and others greatly simplified. This amendment warrants hope for progress after much procrastination, but without intelligent public support it may be sidetracked or emosculated by the next legislature.

In the Public Interest

FACED with the question of whether or not to authorize the construction of a railroad into a section of Texas now served by only one road, the Interstate Commerce Commission has made a decision which should meet with general approval throughout the country. The Commission had before it for consideration the application of a subsidiary of the Southern Pacific Company for permission to build a railway into the lower valley of the Rio Grande in Texas, a large area partly arid and partly irrigated and very fertile. The territory is served now, and well served, by a subsidiary line of the Missouri Pacific, but the Southern Pacific seeks to extend its tributary lines into the valley to open up Western markets to the fruit and vegetable growers of the region. Its proposal was strongly opposed before the Commission by the Missouri Pacific on the grounds that the territory is adequately served by its lines and that there is not sufficient traffic for two railroads.

The question was a difficult one to decide. To prohibit construction of the new railway would insure to the Missouri Pacific a satisfactory return upon its large investment in developing the territory. To authorize the construction might so divide the traffic that neither railroad would make money. A large part of the irrigated land is now taken up and it is not definitely known how much more can be irrigated. The possibilities of the semi-arid section are in doubt. Should the commission for the sake of giving the territory added markets and with the possibility of stimulating further development approve the new line? The majority decided that it should. Its chief argument in favor of such a decision was that the territory which produces mostly perishable fruits and vegetables, products which must reach their market quickly, should not be dependent upon one single-track railway for access to its markets, a railway built in part along the coast and subject to interference by gulf storms. Moreover, the majority believed that the producers of the valley should be given access to the West Coast markets when such access could be provided at the comparatively small expense involved in the construction of the railway proposed by the Southern Pacific. The majority assumed, also, that the agricultural possibilities of the valley have not nearly reached their limit. Therefore, it ordered the line built.

The decision seems to bear out the spirit of the Transportation Act. The Act gave the Interstate Commerce Commission the power of life and death over all new railway construction, placing upon it the responsibility for determining whether any proposed railway was required by "public convenience and necessity." It is hardly conceivable, however, that Congress in investing the commission with such great authority intended to do more than place a check upon needless and wasteful railway construction. To have done otherwise would have placed in the hands of a few men power to arrest the normal development of any part of the country. If there is, therefore, the slightest reason for believing that the progressive development of any territory may come from the construction of a new railway, the commission should consider that it has no alternative but to authorize such construction when any railroad company is willing to undertake it. Any other course would invest it with powers over the development of the country which it has no right to assume.

Rapid Work in Repaving Lindell Boulevard in St. Louis

Macadam on Telford Laid in 1886 Resurfaced in 1904 With 2-In. Bitulithic Is Being Used as Sub-Base for Bitulithic on Concrete Base Constructed This Year

By W. W. Horner
Chief Engineer Sewers and Paving, St. Louis, Mo.

LINDELL Boulevard is the show thoroughfare of St. Louis. It is a street of unusual width from the viewpoint of our earlier city planning and of straight alignment and it joins the Grand Ave. civic center with Kingshighway Boulevard at the main entrance to Forest Park. For many years, the street was lined with the most pretentious homes of the city, but recently its character has been changing by redevelopment along the line of hotels, clubs, and high-class apartments. This street is now being paved for the third time in its history.

Original Macadam on Telford—The first paving, in 1886, was typical of the better class of waterbound macadam work of that period. The street was laid out with 20-ft. sidewalks, including wide planting strips, and a 60-ft. roadway between curbs of which 4 ft. on each side were taken up by the combination curb and gutter. The pavement between gutters consisted of a well laid telford base 8 in. thick, a layer of approximately 6 in. of waterbound macadam, and a top dressing of what was known as Novaculite, a cherty material containing considerable red clay binder. Under maintenance, this macadam surface was built up from time to time so that at its first reconstruction in 1904, the pavement had a total thickness of about 18 inches.

Resurfacing of Bitulithic—The 1904 paving was carried out immediately in advance of the St. Louis World's Fair, the contract being awarded on April 8, 1904, and the work completed on June 7, 1904. This reconstruction involved scarifying and removing a small portion of the waterbound macadam surface, adding clean macadam which was given a light penetration of tar, and surfacing with 2 in. of bitulithic. This bitulithic was of the earlier type laid under that name. The coarse aggregate was crushed granite from a very hard red Missouri stone; the bitumen was a tar product prepared by the Warren Brothers Co. and called "bitulithic cement." While details are not available, it is clear that this repaving was done in remarkably fast time.

The resulting pavement was undoubtedly satisfactory and was for years pointed out as the handsomest in the city. Up to 1920, it had received very little repair and was in first-class condition. The effect of the heavier truck traffic, however, began to be apparent about that time, and waviness developed in the two main traffic lanes. By 1922, riding qualities had become quite unsatisfactory to the critical public and repaving was demanded. Proceedings were started about that time, which have led to the present reconstruction. At the time the pavement was torn up, fully 50 per cent of the area was as satisfactory as when laid, and if this pavement had been on a minor street instead of a thoroughfare of the prominence of Lindell Boulevard, it would undoubtedly have been considered satisfactory for a number of years' additional use.

FIG. 1—POWER SHOVEL REMOVED OLD BITULITHIC AND PORTION OF MACADAM BASE

New Pavement Structure—In advance of the 1926 repaving, a large number of cross cuts were made through the displaced areas of the old pavement. It was found that in some instances the bituminous surface was responsible for the displacement, but in many

FIG. 2—TWO PAVING MIXERS SIDE BY SIDE PUT IN CONCRETE BASE

others, the movement apparently extended to and into the subsoil. This is a very plastic clay and, in many of the test holes, was found to be quite damp. While the truck traffic on this street has been restricted to a great extent, motor bus traffic has been added and it was felt that in advance of the laying of a new expensive surface, an additional strengthening of the foundation was economically justified. It was therefore decided that the reconstruction should provide for the removal of the old bituminous wearing surface and for the greater portion of the waterbound macadam between the surface and the telford base, and that the old telford base would be left in place with as much of the waterbound macadam as might be necessary to prepare for an additional base of about 6 in. of concrete and a new bituminous sheet surface. The cross-sections were modified to provide for somewhat lower crown than that in the previous pavement. As a result the removal of the macadam was carried down to about the top of the telford base in the center, while near the gutters an average of about 2 in. of macadam remained above the telford. In a few instances it was necessary to remove some of the old telford base to get the lower crown required.

Estimates were prepared for reconstruction in this manner, giving cost which included either a new wearing surface of standard 3-in. sheet asphalt or of Warrenite bitulithic. It appeared at the public hearings that the service rendered by the old bitulithic pavement had created much good will, and there was a decided sentiment for the use of the same type of surface in the 1926 construction. The decision of the Board of Public Service accordingly provided for the use of a bitulithic surface.

The St. Louis specifications for bitulithic for use under heavy traffic require that the coarse aggregate which is graded according to the Warrenite bitulithic formula, shall be either crushed granite or trap rock, or a stone of similar hardness. The stone used in the new pavement is from the very unusual deposit of so-called trap rock at Pilot Knob, Mo. It is commonly called a black porphyry. A typical report on this material is: Specific gravity, 3.37; toughness, 17; hardness, 20; percentage of wear, 1.8; and French coefficient of wear, 22.2.

The bituminous surface is specified to be rolled out at the rate of not less than 230 lb. per sq.yd. but actually the pavement is being laid with an average thickness of about 2½ in. The coarse bituminous mixture is raked out in the usual manner, flattened out with a heavy hand roller, then covered with about 60 lb. per sq.yd. of fine graded seal coat mixture, and the whole surface then rolled in the usual manner.

Construction Methods — On the Lindell Ave. job, two 10-ton three-wheeled rollers and one tandem are kept continually in operation. The surface is tested

FIG. 3—LAYING 2-IN. BITULITHIC ON CONCRETE BASE

with a 10-ft. straightedge and all holes or depressions of as much as ½ in. were corrected before the final rolling was completed.

The contract for the work was awarded to the Granite Bituminous Paving Co., of St. Louis. In view of the importance of this thoroughfare, the time limit was comparatively short, but the company, in a desire to emulate the construction record of the previous "World's Fair" pavement, prepared an operating schedule to finish in a shorter period. The actual construction work was exceptionally well organized and is beating the rapid schedule proposed.

The construction operations consisted of the following stages: First, the removal of the old bituminous wearing surface and a greater part of the underlying macadam. It was found that this could be readily done with a steam shovel (Fig. 1) and the operator is able to cut quite closely to the new subgrade. The big bulk of the material was excavated in this way, and loaded directly into trucks. The street was then rough shaped with a blade machine which threw up windrows throughout the length of the job, the material from these windrows being loaded largely with elevating loaders. The pins were then set and the final shaping done by hand. Immediately following the steam shovel work, all subsurface structures were reinvestigated, practically all of the gas and many water services being renewed.

At this point an unexpected situation was discovered in that the clay subsoil in two blocks and in a portion of one other was found to be completely saturated, the plumbers' cuts dug below the subgrade invariably showing standing water overnight. All of the water-works' properties were retested for leaks, but nothing of a serious nature was found. It was finally concluded that this situation was an occurrence of normal subsurface water, and this idea was borne out by old records of springs in the general vicinity. This condition was remedied by laying a line of drain tile down each side of the street about 4 ft. out from the curb. This tile was laid slightly lower than the level of the gas and water cuts, and the trench over the tile drain and all cuts made during reconstruction, were refilled with the surplus macadam removed from the old pavement base, all of the clay excavated in the various trenches being hauled off the work.

Subsequent stages of the construction involved the laying of the new concrete base on top of the old telford remaining and the laying of the new bituminous wearing surface. The actual improvement is 9,000 lin.ft. The amount of grading, including the old wearing surface material, is about 13,000 yd. and the surface area 53,000 sq.yd. The grading was started on May 2. The first concreting was started on May 25, and the laying of the new surface on June 15. Two concrete mixers, Fig. 2, were used in parallel on the base work and the output for both concrete base and wearing surface, Fig. 3, exceeded 2,500 sq.yd. per day for the days worked. Both of these operations were delayed somewhat because of the interference of the tile drainage work and the replacement of service pipes which followed the grading operation. By July 3, 70 per cent of the street had been completed and reopened to traffic. On July 26 the street was reopened, complete except for a short section where the work must be carried out in two longitudinal halves in order to take care of traffic on a branching thoroughfare.

Home-Made Electrolytic Chlorine at Sacramento

Flexibility of Control and Economy Characterize Operation of Chlorination Direct from Chlorine Cells

By Harry N. Jenks
Superintendent, Pumping and Filtration Works, Sacramento, Calif.

THE Sacramento filtration plant is among the few in the United States where chlorine is manufactured for direct application to the filtered water as the final step in the treatment of the municipal supply. Experience with this recently developed method of chlorination, extending over a period of a year and a half, has demonstrated its ease of accurate control of the dosage, coupled with a substantially decreased cost of chlorination compared with the conventional method.

Anticipating the advantages of the local production of chlorine that were later to be realized, the designers of the Sacramento rapid sand filter plant decided on the installation of electrolytic chlorine apparatus, all of which has been retained except the original cells. The operation of these units turned out to be better protected by patents than by good design. After having been completely revamped in essential particulars in order to insure the uninterrupted operation of the plant, the cells were operated intermittently from the summer of 1924 to October, 1925, after which they were abandoned upon the completion of the present enlarged installation. The original cells served the very useful purpose, however, of proving the practicability and economy of the local manufacture and application of chlorine, in conjunction with filter plant operation.

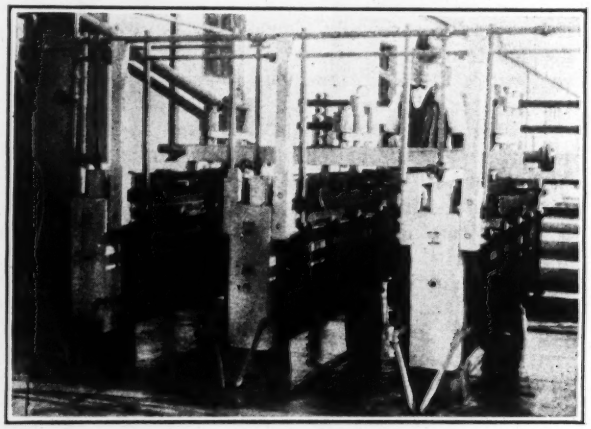


FIG. 1—INSTALLATION OF ELECTROLYTIC CHLORINE CELLS
Due to mild climate cells are located out-doors near one of the filters where accidental discharge of chlorine will do no harm.

The Sacramento installation is shown diagrammatically in Fig. 3. The equipment consists essentially of direct-current generating apparatus together with suitable control and switching panels and electrical connections, supplying six 600-amp. electrolytic cells arranged to operate in series. Commercial rock salt is stored in a bin and weighed on nearby scales as it is placed from time to time in the brine saturator. The electrolyte is further prepared for use in the cells by passing it through a brine filter, after which it is pumped into a brine storage tank, thence flowing into

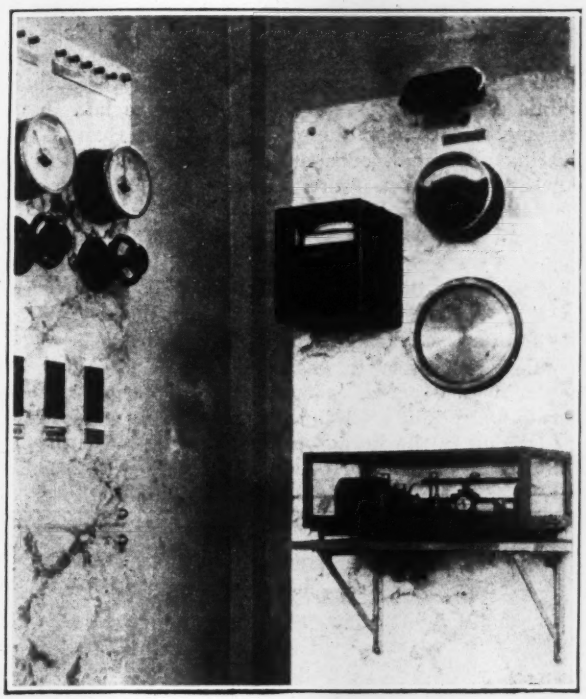


FIG. 2—CONTROL PANEL BOARD FOR CHLORINE APPLICATION

The control board is on board at left; the master rate-of-filtration gage is mounted in the middle of the board at right.

cells through the brine supply pipe. Caustic soda and brine are removed from the cells through the effluent drain pipe. The chlorine gas generated in the cells is taken off from the top of each unit in chlorine dosing lines, one leading to the filtered water and the other to the raw water. The quantity of chlorine applied to the water to be treated is regulated from a control

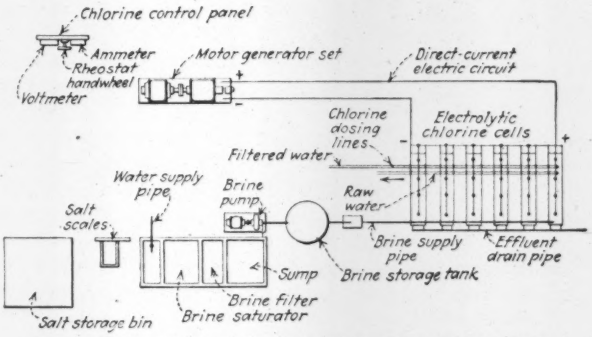


FIG. 3—DIAGRAMMATIC LAYOUT OF SACRAMENTO CHLORINE MAKING PLANT

panel located in the filter operating gallery, shown on the left-hand side of Fig. 2. The large dial on the panel board at the right indicates the rate of filtration on the basis of which the operator regulates the chlorine dose merely by turning the handwheel of a rheostat so as to obtain, for the given rate of filtration, an ammeter reading corresponding to that set down on a chart prepared for the purpose.

Features of Design—Chlorination plays an important rôle in filter-plant operation at Sacramento as a means of neutralizing the tastes and odors resulting from heavy algal growths in the river water during summer months. From the first year of operation, the advantages of double chlorination became so apparent that it was decided to design the enlarged electrolytic plant to enable chlorine to be applied not only to the filtered water but also to the raw water as it enters the treatment works.

A new 600-amp. motor-generator set was added, to be operated in conjunction with the six 600-amp. cells designed by the filtration-plant staff. The two original motor-generator sets, of 300-amp. capacity each, are operated in parallel to serve as a duplicate set for the generation of the required current. The present plant has a nominal capacity of 228 lb. of chlorine per 24 hours, being large enough to meet maximum requirements of double chlorination for a number of years to come. The cells are placed out-doors, as shown in Fig. 1, their operation being unaffected by California weather. In such a location any gas that may escape accidentally from the cells will do no damage.

All chlorine lines are of chemical lead pipe, or heavy rubber water hose. A hard-rubber ejector and an acid-lead ejector are used for the withdrawal of chlorine from the cells and application to the filtered and raw water, respectively. A preliminary chlorine solution is thus effected by the water employed in the operation of each of the ejectors. Fig. 4 indicates clearly the chlorine lines as they are installed above the cells. At the time the photograph was taken, the raw-water line (at the right) was not in service.

Cost of Operation—The investment charges against the electrolytic chlorine-plant installation are included in the unit operating cost per pound of chlorine produced. Depending on the amount used during the year, the cost varies from 5 to 7c. per lb. in contrast to 12.5c. per lb. as the average price paid for liquid chlorine

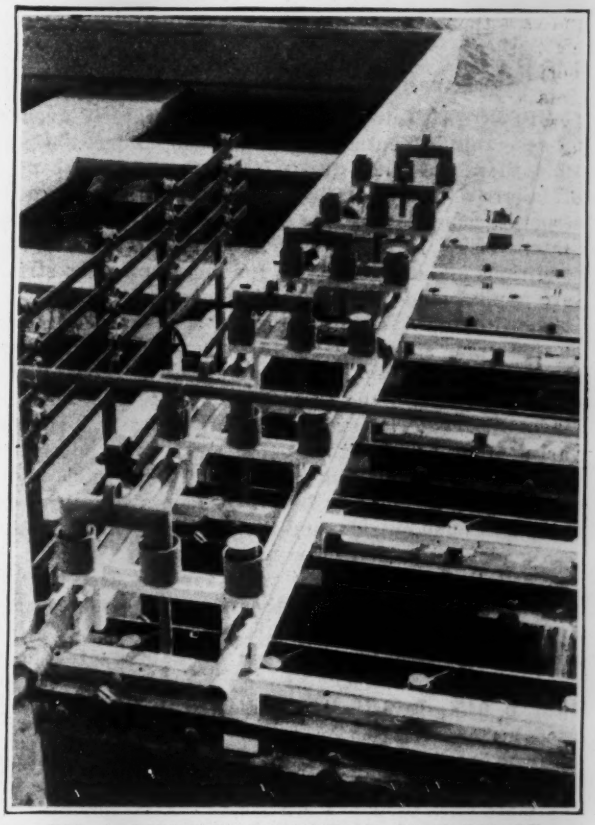


FIG. 4—COLLECTION MANIFOLD OVER TOP OF CHLORINE CELLS

Left pipe is for filtered water, right pipe (not yet connected) for raw water.

alone, exclusive of dosing equipment for the latter. Based on the total chlorine consumption for the year 1925 of 15,600 lb., of which 15,000 lb. was produced electrolytically at the plant, the cost was very closely 12c. per million gallons of water treated.

In brief, considering the expenditure for chlorination as comprising the cost of the disinfectant together with the cost of applying it, under conditions obtaining at the Sacramento filter plant, the cost of locally-made electrolytic chlorine and its application is materially less than that of purchased liquid chlorine and its application by means of standard chlorinating apparatus. When also the flexibility and ease of accurate control are taken into account, it appears that there is a wide field of usefulness, in the chlorination of either water or sewage, for what might be termed the "home production" of electrolytic chlorine. This is particularly true in the case of the larger treatment plants.

For the original conception of the probable advantages of the electrolytic method of chlorination, credit is due Charles Gilman Hyde, designer of the Sacramento pumping and filtration works. Under the direction of the writer, Charles Lundelius of the operating staff prepared the design of the chlorine cells of the enlarged electrolytic plant, while Carl M. Hoskinson, chief engineer, planned the corresponding electrical installation.

Rebuilding Reservoir That Failed at South Pasadena

Buttressed Wall Replaces Part of Original Earth Fill—Old Floor Slab Salvaged by Providing New Joints

By Ormond A. Stone
Assistant Engineer, Olmstead & Gillelen, Los Angeles

SUBSEQUENT to the failure of the Garfield avenue reservoir in South Pasadena, which occurred late in 1924, there was much discussion of the probable causes of failure and of the most economical method of reconstruction consistent with the fact that the area immediately below is thickly populated. A review of the conditions and of the reasons for redesigning the structure is presented in the following:

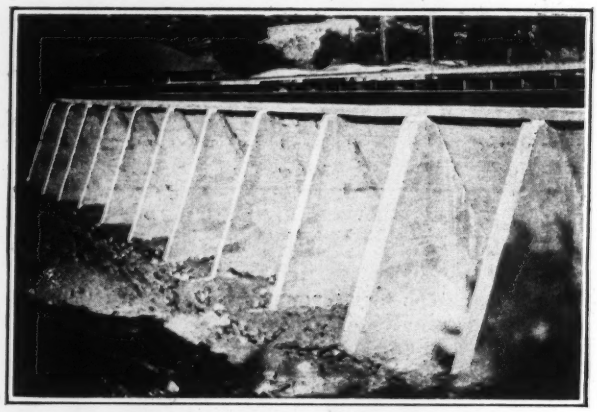
The Garfield Avenue reservoir was designed to serve as the major storage basin for a new source of water supply developed by South Pasadena. It was of the embankment type, the embankment being largely a fill made with material excavated from the site. The fill varied from 4 to 12 ft. in depth and was faced on the inside with a 4-in. concrete lining. The total depth from floor to coping was 16 ft.; the slopes were 1½:1 on both inside and outside, and the top of the embankment was made 9 ft. wide to carry a roadway.

When the reservoir was filled for the first time a break occurred at the southeast corner and carried away the embankment at this point for a length of about 20 ft. and scoured 6 or 8 ft. below the floor level, as described in *Engineering News-Record*, Oct. 10, 1924, p. 645. Investigation indicated that the material used in the construction of the embankment was not uniform in character and contained a large percentage of gravel and boulders. The finer materials were for the most part very fine red loams. Also, during construction it had been exceedingly difficult to compact the fill thoroughly.

The most probable cause of the failure seems to lie in faults which are inherent in the design of this structure and have been the cause of trouble in many other reservoirs of the same type. This cause, in the author's opinion, is the fact that cold joints were laid in the pavement slabs with no provision other than a thin coating of asphalt over the top of the crack to allow for the contraction of the pavement attendant upon the cooling of the concrete by the water.

Again, the corners of the original structure were rounded apparently without consideration of the fact that rounding the corners puts tension in the pavement on the slope. The theory as to the cause of the failure is therefore outlined as follows:

When the reservoir was filled for the first time the concrete contracted, allowing percolation of water through the joints. Joints at the corners were opened by tension in the lining on the curves. The large percentage of gravel and boulders made the embankment



BUTTRESSED SECTION OF WALL BEFORE BACKFILL

pervious, allowing the seepage to increase in volume until it reached the proportions of stream flow with attendant erosion and cutting, causing the failure of the embankment.

The roof on the original structure had no gutters or other means of conveying rain water from the roof over the embankment. As a result the runoff from the roof soaked into the embankment and built up a hydrostatic head on the outside of the lining. During the time that the reservoir remained empty after the break, this external pressure along the west side ruptured the lining about 3 ft. above and parallel to the floor, bulging it inward about 6 in. The rains had also caused settlement in other parts of the embankment with resultant cracking of the 4-in. lining.

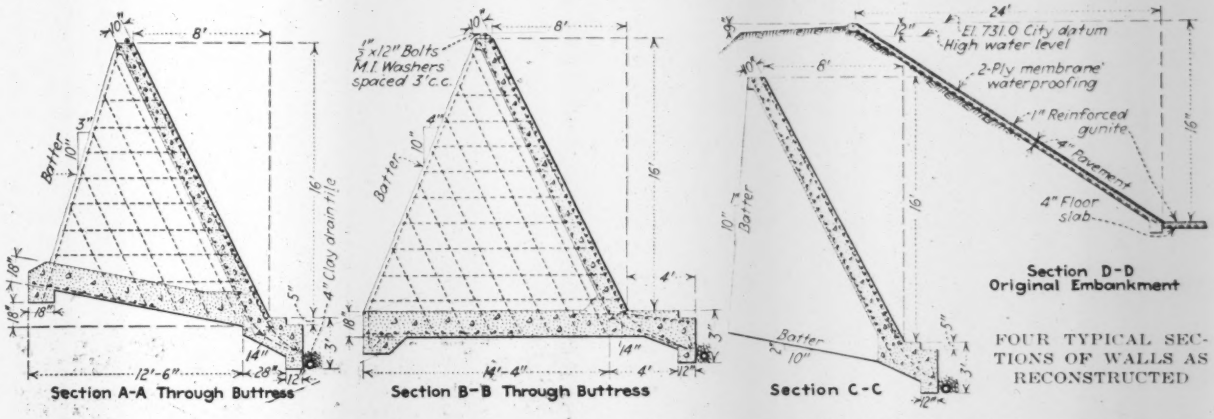
In planning reconstruction it was decided that any attempt to utilize existing lining would result in a structure of uncertain strength whose stability might reasonably be questioned. On the east side where the embankment had been built along a deep gulch it was decided to replace it by a reinforced wall whose stability and strength could be determined accurately. A similar type of structure was decided upon for the south side and part of the north and west sides.

Two types of walls were considered, a counterfort retaining wall and an Ambursen type wall. The latter was more economical and it was found possible to make the deck on a much steeper slope than usual because the

footings for the buttresses, being considerably below the original ground line, could be inclined upward from the low point at the inside. The section adopted gave a slope of ½ to 1 on the inside face of the wall.

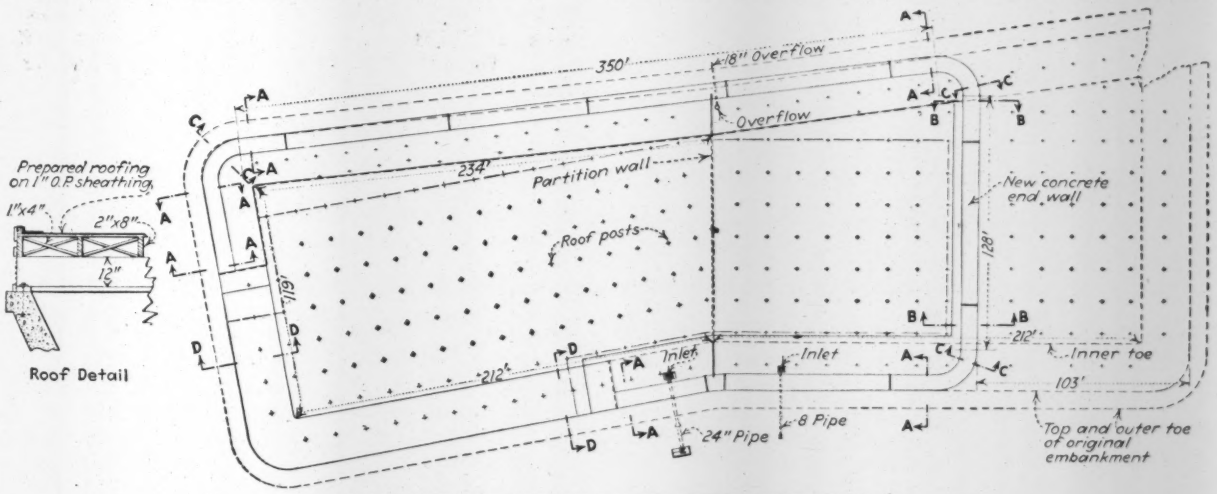
In pouring the floor of the original reservoir the work had been done in alternate strips, 15 ft. wide, extending the entire length of the structure, much in the same manner as concrete road would be poured, leaving cold longitudinal joints and providing no transverse joints of any sort. In the reconstruction it was decided that most of the old floor slabs could be salvaged and accordingly the cold joints in the old floor were chipped out with an air drill for a width of about 12 in. and transverse joints were cut at right angles so as to lay out the old floor in squares about 15 ft. each way.

membraned with 2-ply impregnated burlap laid in bituminous pitch put on hot and later covered with a blanket coat of gunite 1 in. thick. All of the inside face of the new concrete work was waterproofed by coating with a patent bituminous product. Where the buttress type walls were substituted for embankments contraction joints were provided at intervals of about 70 ft. and were made at the buttresses which were widened at those points.



FOUR TYPICAL SECTIONS OF WALLS AS RECONSTRUCTED

When the work on the reconstructed reservoir was finished it was filled before any backfill was placed against the outside of the concrete walls. The reservoir was kept full for two weeks and during this time close inspection failed to reveal the least evidence of moisture coming through the concrete. No seepage



PLAN SHOWING OLD AND NEW RESERVOIR WALLS

Narrow beveled forms were then set in the middle of these cuts in the floor to provide joints which could later be filled with plastic material. The top of these joint forms was brought to a level ¾ in. above the old floor, a mesh reinforcing was laid and then gunite was shot around the joints as well as over the floor. This provided a blanket of approximately 1 in. of reinforced gunite over the old floor slab. After the forms were removed, oakum was calked into the joints and the oakum covered with about 3 in. of bituminous mastic. The joints were then membraned with a 3-ply impregnated burlap.

That portion of the original embankment which was used in the reconstruction, being largely in fill, was flowed from a 4-in. drain tile laid completely around the structure on the inside of the wall about 2 ft. below floor level.

Special credit is due the William Ledbetter Co. of Los Angeles, subcontractors on this job, in that the wall which measured some 19 ft. on the slope was poured, between construction joints, from top to bottom in one pour without showing rock pockets. This was possible only by using the greatest care in preparing the mix and constant and vigorous spading of the concrete as it went into the forms. Fred A. Noetzli, consulting engineer, Los Angeles, was associated with Olmsted & Gillelen, consulting engineers, in the checking and design of the structural features.

Operations of Baltimore Sewage-Works, 1920 to 1925

Use of Imhoff Tanks Resumed then Given Up Except for Long-Time Test of Separate Sludge Digestion—Other Methods of Sludge Disposal and Some Data Back to 1912

By C. E. Keefer
Engineer of Sewage Disposal, Baltimore, Md.

DETAILS of the operation of the Baltimore sewage-works from 1912 to 1920 were given in a paper entitled "Nine Years' Operation of the Baltimore Sewage Works," by T. C. Schaetzle, *Engineering News-Record*, July 14 and 21, 1921. Furthermore, a short paper by the writer called "Operating Results of Baltimore Sewage-Work, 1919-22," *Engineering News-Record*, Feb. 7, 1924, presented certain chemical and bacteriological results on probability paper. The purpose of the present article is to discuss the various problems which have been met in the operation of the sewage-works since 1920, and to bring the data up to date.

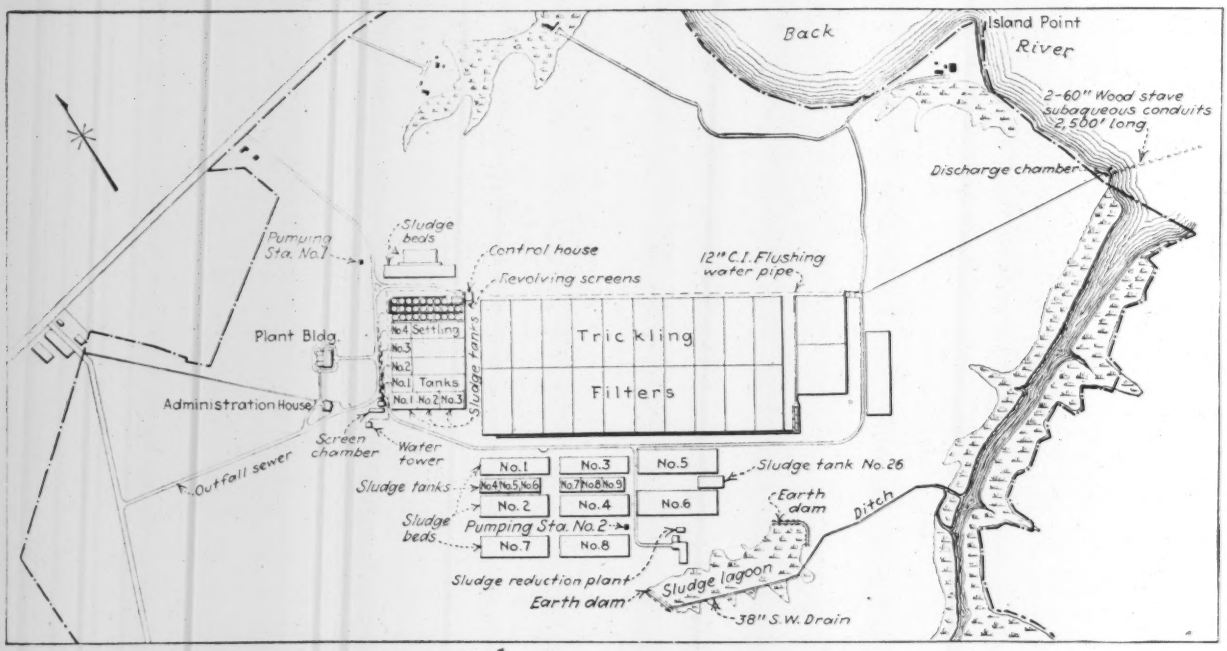


FIG. 1—LAYOUT OF BALTIMORE SEWAGE-WORKS

Previous to 1920 the operation of the sewage-works was greatly handicapped by lack of funds both to operate the plant to its highest efficiency and to construct much needed treatment units. Since 1920 more than $750,000 has been spent on building settling tanks, sludge tanks, sludge-drying beds, pumping stations, etc., so that with the existing works and those under contract it is expected that the plant will be adequately equipped to treat the present flow of sewage. Additional funds have also been provided since 1920 to operate the sewage-works more efficiently and the benefits derived therefrom are becoming apparent.

Brief Description of Works—The sewage (see general plan, Fig. 1) flows through a bar-screen house to a meter house, and from there through two settling tanks, each of which has a working capacity of 3,800,000 gal. There are four settling tanks in all, two of which are kept in continuous operation. The settled sewage continues through four revolving screens, and thence through conduits containing butterfly valves to the trickling filters, which are 8.5 ft. deep and cover 30 acres. Upon leaving the filters the sewage flows first through two final settling tanks, and then through effluent conduits, which are 2,500 ft. long, into Back River.

Bar screens—The bar screens consist of bars 1¼x½ in. in cross section, spaced ⅞ in. apart, set at an angle of 76 deg. with the horizontal. They have a total surface area of 1,125 sq.ft. when they are completely submerged, and the area of the clear openings is 674 sq.ft., which is almost six times the cross-sectional area of the outfall sewer at its outlet. The screens are 11 ft. 10 in. long, and are cleaned with rakes by hand. The rakes are so long and the slopes of the screen are so steep that removal of the screenings is a somewhat difficult matter. The floor of the screen chamber on which the operators stand is 2 ft. below the top of the outfall sewer, and when the flow gets to be more than approximately 60 m.g.d. this floor is flooded, and the screens are cleaned under difficulties. Under normal conditions only half of the screening area is used. Two men working on one 8-hr. shift a day keep the screens clean. On one occasion when the flow of sewage was 138.5 m.g.d., the floor of the screen chamber became flooded with about 3 ft. of sewage. Fortunately this flow lasted for only a few hours and after it had subsided it was possible to get to the screens and clean them. As a partial remedy for this condition, a bypass with a capacity of about 14 m.g.d. has been built around the primary settling tanks in order to lower to some extent only during excessively high flows the elevation of the sewage in the screen

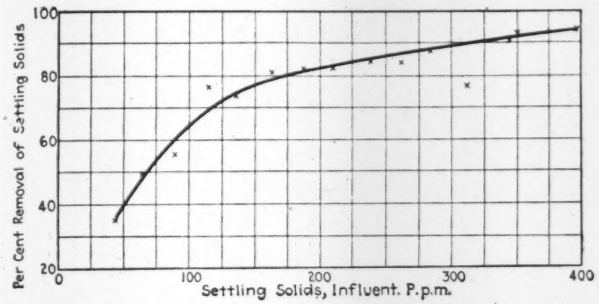


FIG. 2—PER CENT REMOVAL OF SETTLING SOLIDS BY SEDIMENTATION AT BALTIMORE SEWAGE-WORKS

chamber. Alterations to overcome these difficulties are proposed.

Table I gives the yearly quantity of screenings per million gallons of sewage. Farmers buy the screenings for 25c. a load, compost them and use them for fertilizing purposes. No routine analyses of the screenings are made. The moisture content is about 83 per cent, and the volatile matter about 88 per cent.

Primary Settling Tanks—The primary settling tanks were designed as plain settling tanks. However, a considerable amount of septic action takes place in them, depending upon the length of time they are kept in service. It is becoming more and more apparent that they should be cleansed at frequent intervals, at least every 10 or 15 days. If the tanks are cut out of service at the end of this period, and the supernatant liquid is removed, it takes a very short while to clean them; for the sludge is then in a more liquid condition, and little water has to be added to flush the sludge to the pumps. Three men are required when a tank is being cleaned. One man attends to the motor-operated centrifugal pump which pumps the sludge to the digestion tanks. The other two men work in the bottom of the tank, and flush the sludge to the pump by means of a 2½-in. fire hose.

An additional settling tank was completed in September, 1921 (*Engineering News-Record*, Oct. 20, 1921),

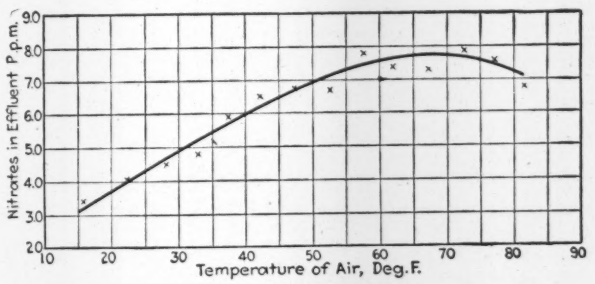


FIG. 3—RELATION BETWEEN TEMPERATURE AND NITRATES IN BALTIMORE TRICKLING FILTER EFFLUENTS

and with this added unit it has been possible to clean the tanks more frequently. This betterment of the operation has been reflected in an increase in the average removal of settling solids of from 67.5 per cent in 1920 to 93.3 per cent in 1925 (Table II), and in an increase in the amount of raw sludge collected from 6.37 cu.yd. per m.g. in 1920 to 9.91 cu.yd. per m.g. in 1925. When it is considered that these tanks were designed almost twenty years ago, they have functioned very well. However, in the light of more modern improvements in sewage treatment it is possible that any future tanks would be of a different design.

To determine the relation between the amount of suspended solids in the influent of these tanks and the per cent removed by sedimentation, a study was made of the analyses of the sewage from 1914 to 1923 inclusive. Considerably over 300 analyses were studied. An average was calculated of all those analyses of the suspended solids in the influent which fall within a narrow range together with the analyses of the effluent. With these results it was possible to plot Fig. 2, which shows that the per cent removal of settling solids increases with the amount in the raw sewage. No analyses were discarded in plotting this curve, and no consideration was given to the fact that there was a considerable variation in the sedimentation period nor to

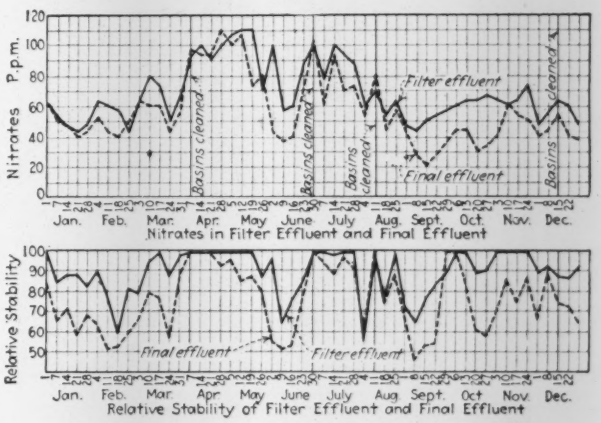

Nitrates P.p.m.
Basins cleaned
Filter effluent
Final effluent
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
Nitrates in Filter Effluent and Final Effluent
Relative Stability
Final effluent
Filter effluent
Relative Stability of Filter Effluent and Final Effluent

FIG. 4—NITRATES AND STABILITY, BALTIMORE SEWAGE-WORKS

the length of time the tanks had been in service. For these reasons the curve is not based on strictly comparable data but it does indicate that higher percentages of removal can be expected from a sewage containing a high rather than a low settling solid content.

Imhoff Tanks—After having worked erratically for a number of years the use of the Imhoff tanks was discontinued in 1917. It is imposible to account fully for the performance of these tanks. It is likely, however, that one of the reasons for the results obtained was that the sludge compartments were based on 1 cu.ft. of sludge storage per capita. This volume does not seem to be large enough for the settling solid content in the sewage. One other possible reason was that

TABLE I—SCREENINGS REMOVED FROM BAR GRATINGS AT BALTIMORE

Year	Average No. of Wheelbarrow Loads per Day	Cu.Ft. per Day	Cu.Ft. per M.G.	Cu.Ft. per Year
1916	18.83	70.613	1.80	25,844
1917	34.46	129.225	2.91	47,167
1918	32.70	122.625	2.32	44,758
1919	30.70	115.125	2.09	42,021
1920	37.30	139.875	2.68	51,194
1921	39.50	148.125	3.18	54,066
1922	53.00	198.750	4.19	72,544
1923	48.00	180.000	3.74	65,700
1924	54.00	202.500	3.79	74,215
1925	55.00	206.250	3.74	75,205

during a period of the day when the flow in the outfall sewer leading to the sewage-works was small, the hydraulic conditions were such that the flow in the tanks was reversed. In 1919 it was decided to give these tanks another trial. Two of them were remodeled so

that the last-mentioned difficulty was overcome. The flow line of the outlet weirs was slightly raised, and the sewage was inletted by means of weirs around the gas vents. The operation of both these tanks was observed very closely for a number of months. The results obtained were so favorable that 14 additional tanks were altered, making a total of 16 in operation. The removal of settling solids over a period of several months was over 60 per cent. In December, 1920, all of the tanks began to produce a poor effluent. They gassed very freely, and the sedimentation compartment became covered with scum. The efficiency during the last few months they were in operation was only 4.5 per cent. Attempts were made to draw sludge, but it was in the gas vents in the great majority of cases. A stream of water under pressure was introduced into the gas vents to break up the scum, but little if any good resulted. After many efforts to get the tanks to function satisfactorily, they were finally put out of service on Feb. 13, 1921.

Imhoff Tanks Used for Sludge Digestion—The Imhoff tanks then stood idle for over a year. As they represented a considerable investment, and as additional sludge digestion space was greatly needed, it was decided to try the experiment of using them as digestion tanks. Close supervision was kept over them and a large number of chemical analyses were made of the sludge for about one year.

To study these tanks under varying conditions, two of them were emptied and filled with raw sludge; one of the tanks had the cone removed. Two additional tanks were filled with raw sludge, to which had been added approximately 26 per cent by volume of well-digested sludge containing 48.3 per cent volatile matter. These four tanks were allowed to stand undisturbed, with a single exception, for a period of one year during which time no sludge was introduced or removed. The other 22 tanks were filled with raw sludge. At frequent intervals digested sludge was removed from them, and was replaced by additional raw sludge. These four tanks were kept under close observation, and chemical analyses were made to determine the reduction of volatile matter in the sludge.

The results were not entirely consistent, but the following conclusions were reached: (1) The tanks produced a well-digested sludge, free from objectionable odor, which dried well on sand beds. (2) More thoroughly digested sludge was obtainable from the two tanks which were seeded with well-digested sludge. (3) The removing of the concrete cone, or slab, between the upper and the lower compartments produced no material change in digestion. (4) Digestion took place better at the bottom of the tank than at the top, and better at a mid-depth than at the top. (5) Considerable gas action was present in the vents whereas there was practically none in the sedimentation chamber. This condition seemed to indicate that most if not all of the digestion was taking place in the sludge compartment. (6) The withdrawing and the refilling of the tanks with small quantities of sludge helped the gas action, provided it was not done very frequently.

Revolving Screens—The revolving screens, which are used to keep grease and other solid material from clogging the filter nozzles, are built of oak. They are 12 ft. in diameter, 10 ft. long, and make 1 r.p.m. They were formerly covered with 24-mesh monel metal cloth, but this has been replaced with 22-mesh. This metal is secured in place by 9-gage galvanized wire, which is wound around the screen and holds the monel metal in place. The monel metal has to be replaced about once a year, and the galvanized wire about every three months, but either of these repairs can readily be made in three or four hours. With a sewage flow of from 60 to 70 m.g.d. two screens are sufficient if the settled effluent contains only a small quantity of suspended matter. But when the sewage contains a high solid content so that the loss of head through the screen is much greater than 3 or 4 in., additional screens are put in service so as to prevent the sewage from breaking through the metal cloth.

TABLE IV—ANALYSES OF TRICKLING FILTER EFFLUENTS WITH VARYING RATES OF FILTRATION

Rate of Filtration M.G. per Acre per Day	Temperature of Atmosphere Deg. C.	Dissolved Oxygen, P.P.M.	Biochemical Oxygen Demand, P.P.M.	Nitrates, P.P.M.	Relative Stability
1.0	11.1	4.06	48.1	1.48	35
1.5	9.5	4.39	32.9	1.55	37
2.0	7.8	5.25	36.9	2.83	38
2.5	9.8	5.25	25.1	3.06	44
3.0	7.3	5.95	31.4	3.3	44
3.3	6.7	6.81	34.2	3.9	48

TABLE III—ANALYSES OF RAW AND TREATED

Year	Raw Sewage: Solids P.P.M. Suspended	Raw Sewage: Solids P.P.M. Settling	Raw Sewage: Biochem Oxygen Demand P.P.M.	Raw Sewage: Bacteria per C.C. Total on Plain Agar.	Raw Sewage: Bacteria per C.C. Acid Forming	Settling Tank Effluent: Solids P.P.M. Suspended	Settling Tank Effluent: Solids P.P.M. Settling	Settling Tank Effluent: Biochem Oxygen Demand P.P.M.	Settling Tank Effluent: Bacteria per C.C. Total on Plain Agar.	Settling Tank Effluent: Bacteria per C.C. Acid Forming	Rate of Filtration M.G. per Acre per Day	Trickling Filter Effluent: Solids P.P.M. Suspended	Trickling Filter Effluent: Solids P.P.M. Settling	Trickling Filter Effluent: Biochem Oxygen Demand P.P.M.	Trickling Filter Effluent: Nitrates P.P.M.	Trickling Filter Effluent: Relative Stability Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1912	54	...	...	1,900,000	56,000	31	...	.....	.....	.....	2.73	22	...	...	8.3	98
1913	122	...	115	1,700,000	360,000	76	...	129	1,300,000	310,000	2.64	56	...	30	8.2	93
1914	120	...	131	2,300,000	150,000	85	...	190	3,300,000	230,000	2.72	60	...	41	7.2	78
1915	256	183	113	1,'00,000	160,000	109	58	153	1,100,000	210,000	2.88	89	68	37	6.2	87
1916	138	102	91	1,100,000	89,000	...	35	118	800,000	94,000	2.84	...	48	33	4.4	93
1917	260	69	93	950,000	59,000	...	34	135	850,000	70,000	2.96	...	49	38	7.4	92
1918	287	49	67	800,000	40,000	...	36	114	850,000	63,000	3.00	...	40	32	8.1	96
1919	111	66	127	1,400,000	160,000	...	37	93	700,000	66,000	2.79	...	46	31	7.7	89
1920	172	120	171	2,200,000	320,000	...	39	92	650,000	93,000	2.91	...	27	27	7.0	92
1921	252	191	149	1,400,000	230,000	...	38	92	490,000	80,000	2.86	...	39	27	7.6	96
1922	261	209	195	4,800,000	1,100,000	...	29	125	1,300,000	300,000	2.86	...	38	35	6.3	93
1923	263	214	235	3,100,000	1, 00,000	...	28	109	1,200,000	350,000	2.76	...	39	30	6.6	94
1924	361	251	163	3,200,000	940,000	...	34	108	1,300,000	430,000	2.85	...	37	28	6.9	89
1925	517	434	179	4,100,000	1,400,000	...	29	109	1,400,000	420,000	2.78	...	38	26	5.5	87

TABLE II—SETTLING SOLIDS REMOVED BY PRIMARY TANKS

Year	Per Cent Removal	Year	Per Cent Removal
1920	67.5	1923	86.9
1921	80.1	1924	86.5
1922	86.1	1925	93.3

TABLE V—CAPACITY OF SEPARATE SLUDGE TANKS

Year	Tributary Population	Tank Capacity, Cu. Ft. Total	Tank Capacity, Cu. Ft. Available Allowing 2-Ft. Freeboard	Total Capacity per Capita, Cu. Ft. Total	Total Capacity per Capita, Cu. Ft. Available Allowing 2-Ft. Freeboard
1912	50,195	609,000	525,000	12.13	10.46
1913	132,875	609,000	525,000	4.58	3.95
1914	220,990	609,000	525,000	2.76	2.38
1915	337,555	938,600	817,800	2.78	2.42
1916	415,215	938,600	817,800	2.26	1.97
1917	460,785	938,600	817,800	2.04	1.77
1918	497,805	938,600	817,800	1.89	1.64
1919	505,270	938,600	817,800	1.86	1.62
1920	517,225	938,600	817,800	1.81	1.58
1921	532,840	938,600	817,800	1.76	1.53
1922	560,815	1,568,700	1,367,300	2.80	2.44
1923	586,820	1,568,700	1,367,300	2.67	2.33
1924	645,225	2,728,300	2,406,700	4.23	3.73
1925	673,240	2,728,300	2,406,700	4.05	3.57

Trickling Filters—The trickling filters have continued to give a satisfactory effluent. They usually slough twice a year, and there has been no trouble with imum rate was 1 m.g.d. per acre, and the maximum 3.3, the highest rate which could be applied. The results show that there was an increase in oxidation as the rate of flow increased. The analyses are not entirely comparable as it was impossible to apply exactly the same strength sewages in each case. It is probable that the chief reason why the best results were obtained when the rate of filtration was the highest was because the distribution of the sewage on the

TABLE VII—MOISTURE OF SLUDGE TREATED WITH ALUM AND DRIED ON SAND BEDS

Date	Moisture Content of Sludge, Per Cent Alum Added	Alum Not Added	Remarks
6-21-23	97.0	96.5	Sludge run on beds
6-22-23	85.2	96.0	
6-23-23	82.8	93.2	Clear and hot Rain at night
6-25-23	74.1	83.9	Clear and hot
6-26-23	70.6	73.5	Clear and hot
7-3-23	39.8	49.7	Sludge removed

SEWAGE AT BALTIMORE, 1912 TO 1925

Bacteria per C.C. Total on Plain Agar.	Bacteria per C.C. Acid Forming	Final Effluent: Solids P.P.M. Suspended	Solids P.P.M. Settling	Biochem Oxygen Demand P.P.M.	Nitrates P.P.M.	Relative Stability Number	Bacteria per C.C. Total on Plain Agar.	Bacteria per C.C. Acid Forming	Efficiency Raw Sewage to Final Effluent: Percentage Reduction Solids Suspended	Solids Settling	Biochem Oxygen Demand	Acid Forming Bacteria	Increase In. Nitrates P.P.M.	Increase In. Relative Stability, per Cent
(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
.....	.....	13	...	...	7.5	98	.....	2,400	75.5	...		95.8	7.5	98
180,000	36,500	22	...	13	7.9	99	260,000	16,000	82.3	...	88.9	95.6	7.9	99
470,000	35,000	37	...	26	6.9	92	700,000	24,000	69.0		80.0	84.2	6.9	92
250,000	31,000	43	28	21	5.5	94	750,000	25,000	83.2	84.7	81.4	84.4	5.5	94
290,000	12,000	47	31	22	4.1	92	750,000	11,500	65.9	69.6	75.3	87.1	4.1	92
200,000	12,000	42	27	28	7.4	92	330,000	11,500	83.9	61.4	68.9	80.6	7.4	92
160,000	7,700	46	25	26	7.6	95	500,000	8,500	84.7	50.4	61.2	79.0	7.6	95
190,000	9,300	43	24	24	6.7	92	250,000	13,500	61.3	64.3	81.2	91.6	6.7	92
150,000	13,000	41	18	25	6.5	90	230,000	19,000	76.2	85.1	85.5	94.1	6.5	90
130,000	16,300	56	38	29	6.9	92	230,000	22,800	77.8	80.1	80.9	90.1	6.9	92
210,000	23,000	52	36	38	5.5	85	440,000	67,000	80.1	82.7	80.6	94.0	5.5	85
220,000	64,000	54	34	31	5.4	84	210,000	64,000	79.2	83.0	86.5	93.6	5.4	84
180,000	38,000	51	33	26	5.7	75	200,000	43,000	85.9	86.9	84.0	95.5	5.7	75
230,000	53,000	48	31	28	4.6	75	480,000	110,000	90.7	92.9	84.4	92.1	4.6	75

ponding. There is no indication that the stone, which is trap rock, has disintegrated at all. One man and at times two are employed to keep the nozzles clean. Of the 5,830 nozzles in place the average number cleaned daily during 1925 was 326.

As indicated by Table III the rate of filtration has varied from 2.64 to 3.0 m.g.d. per acre. A study of the analyses of the filter effluent from 1912 to 1923 indicated that the best results were obtained with a comparatively high rate of filtration. To verify this observation different quantities of sewage were applied to one of the three-acre filter beds. The rate of filtration was varied by increasing the head of sewage on the filter nozzles. As indicated in Table IV, the min-filters was more uniform during periods of high flow.

One point of interest in the nitrification of sewage in trickling filters is the effect of temperature on the nitrification as measured by the amount of nitrates in the effluent. With this problem in mind a study was made of the nitrates in the trickling filter effluent for a period of nine years from 1915 to 1924 inclusive, and of the prevailing air temperatures for this period. Averages were calculated of the nitrates which fell within a narrow range together with the average of the corresponding air temperature. The results are indicated in Fig. 3, which shows the variation of the nitrates with the temperature. Unfortunately the temperatures at Baltimore are not low enough during the

TABLE VI—CUBIC YARDS OF SLUDGE COLLECTED AND DISPOSED OF AT BALTIMORE, YEARS 1912 TO 1925

Year	Sludge Collected in Tanks, 90 Per Cent Moisture—Primary Settling Tanks—Undigested Sludge Total Cu.Yd.	Undigested Sludge Cu.Yd. per M.G.	Undigested Sludge Cu.Yd. per Capita	Digested Sludge Total Cu.Yd.	Digested Sludge Cu.Yd. per M.G.	Digested Sludge Cu.Yd. per Capita	Sludge Air Dried 68 Per Cent Moisture Primary Settling Tank Cu.Yd.	Sludge Air Dried 68 Per Cent Moisture Final Settling Tank Cu.Yd.	Times Sludge Beds Were Cleaned Digestion Tank Beds	Times Sludge Beds Were Cleaned Imhoff Tank Beds	Sludge Disposed of—Other Than on Sludge Beds, 68 Per Cent Moisture Cu.Yd.	To the Heat Drying Plant 68 Per Cent Moisture Cu.Yd. Delivered to the Plant	To the Heat Drying Plant 68 Per Cent Moisture Cu.Yd. Taken by the Plant	To Farmers Liquid Sludge 90 Per Cent Moisture Cu.Yd.	To Farmers Air Dried 68 Per Cent Moisture Cu.Yd.
1912	.....	....	.....	6,568	1.520	.....	.....	.....	....	....	.....	.....	.....	.....	.....
1913	.....	....	.....	11,348	1.720	.....	.....	.....	....	....	.....	.....	.....	.....	.....
1914	.....	....	.....	32,233	3.850	.....	.....	.....	....	....	.....	.....	.....	5,835	.....
1915	66,162	5.70	0.2335	47,010	4.047	0.1474	16,546	.....	....	....	2,695	16,546	.....	7,309	1,313
1916	79,488	5.53	0.2260	53,040	3.669	0.1341	16,553	.....	....	....	1,383	14,909	6,803	4,007	835
1917	118,907	7.34	0.2663	51,029	3.149	0.1148	14,520	.....	....	....	404	14,053	3,289	839	1,483
1918	116,866	6.06	0.2416	64,025	3.111	0.1205	14,151	.....	....	....	3,775	14,005	9,521	460	2,485
1919	103,294	5.14	0.2071	59,886	2.981	0.1175	18,108	144	....	....	7,760	17,912	6,261	16	.....
1920	121,503	6.37	0.2392	57,223	3.000	0.1160	22,590	2,059			6,242	21 133	4,307	46	1,537
1921	144,123	8.47	0.2774	52,375	3.022	0.1008	15,601	2,046	3.019	0.833	15,073	14,516	631	6	6,597
1922	157,767	9.22	0.2911	61,796	3.611	0.1166	22,258	2,020	5.46	4.76	4,178	18,955	7,057	24	6,272
1923	168,604	9.59	0.2947	73,008	4.164	0.1276	14,009	.....	3.70	2.27	1,453	12,194	807	1,130	13,431
1924	162,137	8.28	0.2632	58,745	3.000	0.0954	15,530	.....	3.16	0.27	1,363	13,926	.....	.....	12,160
1925	199,193	9.91	0.2959	84,558	4.280	0.1256	20,981	.....	4.32	....	8,750	20,981	.....	.....	7,155

winter to furnish a sufficiently large number of analyses so that the curve could be plotted with any precision between 0 and 15 deg. The curve indicates that the temperature which would produce the highest nitrification would be at about 70 deg. and that a temperature much higher than this would possibly lower the nitrification.

Final Settling Basins—Since 1920 the final settling basins have not given entirely satisfactory results. The

TABLE VIII—OPERATING COST OF BALTIMORE SEWAGE WORKS

	Sewage Flow				Cost of Operation		
Year	Total M.G.	M.G.D.	Average Weekly Maximum Rate-M.G.D.	Population Contributing Sewage	Total	Per M.G. of Sewage	Per Capita Per Year
1912	4,320.85	11.80	.....	50,195	$20,999.31	$4.86	$0.4184
1913	6,597.48	18.10	.....	91,535	31,667.90	4.80	0.3460
1914	8,372.09	22.94	32.96	176,935	37,674.41	4.50	0.2129
1915	11,607.41	31.80	42.90	279,275	40,045.56	3.45	0.1434
1916	14,374.00	39.27	52.10	376,385	37,290.58	2.594	0.0991
1917	16,199.83	44.38	59.15	438,000	46,686.70	2.882	0.1066
1918	19,284.78	52.84	68.48	479,295	55,193.67	2.862	0.1152
1919	20,096.08	55.06	71.83	501,540	68,112.70	3.389	0.1358
1920	19,074.23	52.12	69.97	511,250	74,420.27	3.902	0.1456
1921	17,015.72	46.62	66.62	525,035	92,080.47	5.412	0.1754
1922	17,333.57	47.49	69.81	546,830	114,785.17	6.622	0.2099
1923	17,581.21	48.17	69.19	573,820	109,800.74	6.264	0.1914
1924	19,581.82	53.50	78.18	616,025	110,016.29	5.618	0.1786
1925	20:108.30	55.09	79.46	673,240	114,299.21	5.684	0.1698

nitrates and the relative stability of the effluent from these basins have been considerably less than in the influent, as shown by Fig. 4. The average detention period in the basins is about five hours. As is evident by Table III, there has been but a small removal of settling solids from 1921 to 1925 inclusive. To try and correct the latter condition the basins will be kept under close supervision during 1926, and they will be cleaned more frequently. In view of the experience which has been had with these tanks, particularly with reference to the decrease in the relative stability and the nitrate content, it is a serious question whether they are serving any real purpose, and the experience which has been had with humus tanks in other cities has not been entirely satisfactory.

Hydro-Electric Plant—The current used at the sewage-works is generated by a fall of 18-ft. of the treated sewage, which drives water-turbines direct-connected to generators. Seven men have been employed to operate the hydro-electric plant, and the cost of the current has averaged 3.9c. per kw.-hr. for 1922-25. As this cost is high in comparison with what current can be purchased for from the local electric company, it has been decided to operate the two electric generators by automatic control, and this equipment is under contract. When it is erected, the personnel of the hydro-electric plant and its cost of operation can be materially reduced.

Sludge Disposal—The sludge from the primary settling tanks is pumped to separate sludge-digestion tanks where it remains until it has digested and can be put on the sludge beds to dry. When a primary settling tank is put out of service to clean, the supernatant liquid is pumped into one of the other tanks in operation. Measurements are then made of the volume of the raw sludge in place, and its moisture content is ascertained. The moisture in the smaller, or first compartments, of the settling tanks averages about 82.2 per cent, and in the second, or larger compartment, about 83.6 per cent. This sludge is flushed through a series of channels in the bottom of the settling tanks to a well where it is pumped to the sludge tanks. The water content of the sludge as it is being pumped averages about 93.4 per cent. This means that to remove 100 gallons of sludge approximately 160 gallons of water has to be added. The adding of this quantity of water naturally has a decided bearing on the volume needed for the digestion of the sludge. The volatile matter in the sludge as it is pumped from the settling tanks is about 76 per cent. This determination is to a certain extent an index of the degree to which the sludge has digested.

Table V gives the space provided for sludge digestion for each year since the plant was put in operation, together with the volume available per capita served by the sewerage system. The difficulties of sludge digestion and disposal during past years have been more or less proportional to the sludge storage capacity. During the early years of operation well digested sludge

TABLE IX—OPERATING COST OF INDIVIDUAL TREATMENT UNITS

Treatment No.	Unit	1921	1922	1923	1924	1925
1	Bar screens....	$5,469.19	$5,544.34	$4,571.48	$5,454.52	$5,790.73
2	Settling tanks	8,974.66	11,733.60	16,944.95	17,372.38	17,231.64
3	Sludge digestion tanks..	8,057.62	9,534.16	12,870.20	14,187.11	16,078.24
4	Imhoff tanks..	4,822.11	3,640.52	3,536.68	2,896.14	.....
5	Revolving screens.....	10,987.67	13,289.15	13,518.24	10,694.38	13,171.15
6	Trickling filters.....	11,500.72	16,599.40	12,602.55	16,247.69	13,483.48
7	Settling basins	3,491.19	3,437.87	4,972.45	5,190.52	4,287.61
8.	Sludge beds..	13,262.19	18,181.37	23,300.63	23,558.90	23,601.03
9	Baltimore Tankage Co.	2,090.67	16,331.68	506.38	.....	.....
	Total.....	$68,656.02	$98,292.09	$92,823.56	$95,601.64	$93,643.88

was obtained, but as the contributing population became greater, difficulties of sludge handling began to present themselves. It became impossible to retain the sludge in the digestion tanks for a sufficient length of time for it to digest thoroughly, and partially digested sludge had to be put on the sludge beds.

The need for sludge storage and digestion space became so urgent that in May, 1920, it was necessary to dispose of the sludge in some way. A tract of level ground approximately 1,700x800 ft., which was designed as the site for future trickling filters, was available, and over 110,000 cu.yd. of sludge containing 90 per cent moisture was pumped there. For further disposal of the large amount of sludge a sludge lagoon was constructed by building two earth dams about 900 ft. apart across a small stream bed. A 36-in. concrete drain was laid to take the flow of the stream. This lagoon has a capacity of 35,800 cu.yd. to an elevation 1 ft., from the top of the dams, and a maximum depth of 7 ft. The total cost of all the work was $23,024. Upon the completion of this work sludge was immediately pumped into the lagoon, and it served a very useful purpose while additional sludge-digestion tanks were being built. Since 1920 additional sludge digestion capacity has been put into service amounting to 1,789,700 cu.ft. As indicated in Table V the per capita capacity in December, 1925, was 4.05 cu.ft. Perhaps with this added volume the immediate needs will have been met, but there is no definite assurance that such will be the case. Table VI gives data pertaining to the sludge collected and disposed of.

It is recognized that one of the most vital factors in the digestion of sludge is its temperature. With this fact in mind a series of temperatures of the sludge in one of the digestion tanks was obtained during the winter of 1922-23. The tank which was used is 38 ft. in diameter, stands about 14 ft. out of the ground, and

is 24.5 ft. deep at the center. Temperatures were taken by means of a recording thermometer in the center of the tank at distances of 2, 11, and 20 ft. from the top of the sludge. At the 2-ft. depth the temperature ranged between 36 and 44 deg.; at the 11-ft. depth, between 42 and 47 deg.; and at the 20-ft. depth, between 42 and 48 deg. The minimum temperature of the air at any one time was 7 deg. and the maximum 63 deg. The lowest average daily temperature was 20 deg. These results make it clear that during the winter months there is a great retardation in sludge digestion, due to the low temperature of the sludge, as is to be expected.

Sludge-Drying Beds—The present sludge-drying bed area is 495,400 sq.ft. or 0.77 sq.ft. per capita. These beds are cleaned by hand (see *Engineering News-Record*, July 3, 1924), and the sludge is hauled to an adjacent dump. The cost of removing the sludge has averaged 83c. per cu.yd. for the years 1921-25. This cost includes not only the labor in removing the sludge but also the money needed to maintain the sludge beds.

As indicated in Table VI, the sludge-drying beds have been cleaned on an average of 3.93 times a year since 1921. This small number is due to several causes. On many occasions sludge, which was not fully digested, was put on the beds, and more time was required for drying it. Furthermore, extensive repairs had to be made such as adding sand to the beds, and the relaying of underdrains. Moreover, in a plant where many acres of beds are used it is not always possible to clean them just at the time when the sludge is in a condition to be removed.

In 1922 a series of experiments were conducted to determine the relative merits of drying beds made of sand as compared with those made of cinders. Two beds were prepared, each with an area of 3,900 sq.ft., and sludge with the same characteristics was applied to each. The results indicated that the sludge dried quicker on the cinder beds than on the sand beds although the water which drained from the former was in a poorer condition than from the latter.

In the light of the work done at the New Jersey Sewage Experimental Station on the air-drying of digested Imhoff tank sludge by the addition of alum, similar experiments were conducted at Baltimore to see if the same results would be accomplished with sludge from separate sludge digestion tanks. The experiments were conducted in the field, and sludge was run on two beds on July 21, 1923. Alum was added to the sludge which flowed to one of these beds. Within a few days it became apparent that the alum-treated sludge was drying more rapidly than the other, and when the sludge was removed on Aug. 3, there was a difference in the moisture content of 9.9 per cent. Table VII gives the results of the experiments. Alum has not been used, however, as the air-dried sludge is given to farmers, and they might discontinue to take it because it might be injurious to the soil. Experiments are being conducted which consist of adding alum-treated sludge to soil planted with various kinds of crops, and a study will be made to find out what its effect, if any, will be.

Cost of Operation—Table VIII gives the total annual cost of operating the works together with the cost of treatment per million gallons and per capita per year. In calculating these costs, depreciation and interest on the original investment have not been added. The total cost of the sewage-works to Dec. 31, 1925, was in round numbers $3,300,000. The actual operation of the plant was less than is indicated as money was spent on numerous items which it has been impossible to allot.

Table IX gives a more exact account of the operating costs, which have been segregated over the various treatment units. All overhead expense, such as superintendence, laboratory work, etc., has been proportioned and added to the various units.

Plant Building—The major portion of the repairs on the machinery, pumps, screens, etc., is done at the disposal plant. Previous to 1923 this work was mostly done in temporary frame buildings which were inadequate. Furthermore, the work was not concentrated in one point, and as a result there was a good deal of lost motion. To overcome these difficulties a plant building was constructed at a total cost of $54,405. This building is a one-story brick structure, 95½x41½ ft. in plan with two 34x26-ft. wings.

The main building contains machine and carpenter shops, which are equipped with power-driven tools. A 3-ton traveling crane, which is available for moving heavy machinery parts, spans the full width of the building. The wings contain a blacksmith shop, garage, locker, toilet and shower rooms. All machine, carpenter, and repair work is now done in this building at a noticeably reduced cost. Furthermore, the providing of locker and toilet rooms for the laborers has had a beneficial effect.

B. L. Crozier is chief engineer of the Department of Public Improvements. The sewage-works is under the supervision of M. J. Ruark, sewerage engineer. The writer is in charge of the design and the operation of the sewage-works, and George K. Armeling is the superintendent.

Occupations of Civil Engineering Graduates of M. I. T.

THE approximate classification by occupation in 1924 of the graduates of the courses in Civil Engineering and Sanitary Engineering of the classes of 1868 to 1924, inclusive, of Massachusetts Institute of Technology, is shown by the accompanying table, which is taken from an official publication of the Institute:

Engaged in Professional Engineering		
In independent practice or with engineering firms	269	
With federal and state engineering forces	101	
Railway engineering (or operation)	85	
Structural engineering	79	
Engineering teachers	70	
Municipal engineering	58	
Sanitary engineering	56	
Highway engineering	44	
United States Army Engineer Corps	35	
Hydraulic engineering (general)	34	
Hydro-electric engineering	25	
United States Navy Civil Engineer Corps	9	
		865
Engaged in construction work with contractors and construction companies, presumably acting in engineering capacities	138	
Engaged with business firms, presumably acting in engineering capacities	176	
		314
Engaged in manufacturing	134	
United States Army or Navy other than Engineer Corps	27	
Bankers and brokers	23	
Miscellaneous	121	
No information available	252	
		557
		1,736

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

CITY HALL, WICHITA, KANSAS

Wichita, Kansas

COUNTY SEAT OF SEDGWICK COUNTY. Fourth flour milling city, broom corn center of the world, location of several packing houses, many oil refineries and farm tools factories. The recent entry into the city of 17c. natural fuel gas for manufacturing will still further stimulate industrial growth. Located on the Arkansas River in the south central part of the state, surrounded by a rich agricultural and oil-producing back country, Wichita commands a large wholesale and jobbing business for the territory to the south and west. Served by six steam and one electric railway, whose tracks leave the city at every point of the compass. Area, 22 square miles. Laid out in 1870. Population 1920 census 72,217, but with annexations of 10,000 and natural growth now estimated at 95,000.

STANDING in the pathway of the vast hordes who, following the Civil War, answered the call of the great plains, Wichita was founded by a small group who left the migrating columns of Kansas homeseekers because here was water, the river could be forded and groves of cottonwood and willows offered shade. Official plats laid out the streets paralleling section lines which had been set by government land surveyors who in 1867 had surveyed Indian lands for homesteaders. To these surveyors, then, Wichita owes its square shape set four-square with the compass, and its long, straight thoroughfares running from the center of town to the county line.

In its early history Wichita was a victim of the Floridian type of boom. In 1886 and 1887 it had such a frenzied financial exploiting of country lots, that by the sub-division route scores of citizens became paper millionaires. After more than a third of a century titles to lots outside even of the present city limits are "held" by absentee owners. In the interest of public welfare the state by law has vacated many of these tracts. After the boom came collapse. For a dozen years the population curve showed a sidewise movement, but a little paving was done, two-and three-story brick buildings were erected in the business district, and Douglas Ave., now the pride of the city, laid out by cowboy surveyors using a 100-ft. wet rope which produced the desirable 114 ft. width of today. For many a year the farmer plowed up sub-division stakes on the outskirts as they have been doing around the mythical 10,000,000 population town the sub-dividers provided for the Los Angeles area 25 years ago, and as will be the case in the 35,000,000 city now being laid out around Chicago. This early boom in Wichita affects the engineer and his work and always will. Besides laying out a town on square lines the numberless uncontrolled sub-dividers produced street jogs without number, provided no axial streets, thus making street car service difficult in the quarter points of the compass, restricting population. In turn this necessitated long lines of sewers with much unused mileage around two sides of a triangle south to the lower part of the city, thence west to the river which in general flows south near the western limits.

Starting out as an agricultural trading center and point to which Texas range cattle were driven, Wichita, on the discovery in 1895 of oil in the vicinity, began another boom which this time the city was able to control and direct. Industries of a stable nature came to stay. At no time has the population curve since the 25,000 of 1900 deviated much from regular even progress upward to the 95,000 mark of today. Characterize Wichita today, then, as an industrial-commercial city, enjoying a healthy growth due to the continual addition of manufacturing concerns attracted by cheap fuel, reasonable labor and nearness to points of consumption.

Topographically, two-thirds of the city is situated on the flat flood plain of the Arkansas which here has a slope of but 5 ft. to the mile, the despair of the sewer designer. The remaining third has about 5 per cent grades. An underground water supply is available. The river, which has been lowered some 7 ft. by gravel production, furnishes concrete aggregates the smallest of which requires extra cement. The engineer has worked this out scientifically by testing "balls" of concrete in a brick rattler. The subsoil is sand 2 to 10 ft. down. Trenches stand well with ordinary bracing and are usually machine dug. Rock is absent. A 3- to 4-sq.mile patch of reddish-yellow clay, which on drying shrinks 20 per cent (7 per cent in linear dimension) has brought from the engineers the ingenious method of laying pavement slabs on 3 in. of sand for the purpose of breaking the bond between the slab and subbase. Wise house builders add a bottom course of gravel under their foundations.

Operating under the commission-manager form of government for 9 years, the city engineer is nominally in the department of public service and has the responsibility of designing and superintending construction of all new work besides handling all matters in which engineering problems are involved. P. L. Brockway, the present incumbent, has been with the city for 18 years and has helped provide facilities in that time for the growth from 40,000 to 95,000 people. An extract from Mr. Brockway's highly interesting letter of invitation to Wichita tells what his job is better than editorial observations. He says:

We have just completed construction of a traffic-signal system which has better visibility than that on Fifth Ave., New York. We have installed within the last year a fire-alarm system. We have designed and constructed a concrete loading-platform with safety guards at the street car stops which are somewhat different from anything I have seen excepting in a picture from a city in New Zealand. Fifteen concrete bridges have been built at a total cost of $750,000. A New York bridge engineer saw one of our plans and knowing the maximum we could pay offered to reduce the concrete quantities 10 per cent if we failed to get bids. As a matter of fact we knew where we could cut the concrete 10 per cent, but that is the cheapest thing we have in this country and we *did* get bids within the limit.

We are reconstructing our rivers at a cost of one-half million or more for flood prevention and beautification of

the streams themselves and we have some outside advice on the hydraulics of the situation. We construct about a hundred different pavement projects every year, most of them short but aggregating 10 to 12 miles. Within the last three years we have designed and built storm sewers aggregating $1,000,000 and incidentally as a result of this work have advised somewhat with consulting engineers on the same kind of work after ours were completed. It is our duty to maintain a troublesome dam constructed for the purpose of keeping flushing water in a bypass channel through the city. It is our responsibility to establish all grades as needed in the city, covering 22 sq.mi.

We have been engaged for five years in a comprehensive survey of the whole city and have established 3,000 land marks during the progress of the work. We have sole and complete charge of the street-lighting system as to renewals and the building up of a general street-lighting design and construction of special illuminating systems. We have nothing in our city like the hybrid gas-electric lights in Riverside Drive near Grant's Tomb. We have for ten years been installing street signs at all the intersections of the city.

I have been a full member of the City Planning Commission since its organization, am secretary at the present time, and get a lively reaction regarding city planning subjects from many of our people. Records of water mains and hydrants are kept in my office, the water plant being privately owned. The office issues permits for connections of sewers and for the construction of sidewalks and other similar work in the streets. These permits alone will run 3,500 to 4,000 during the year. It is the duty of the city engineer by statute to inspect all sidewalks in the city and notify property owners when they are in a defective condition and repair them if the property owner fails to do so. This in itself is a job which requires all of the wisdom of a serpent and the guilelessness of a dove.

As city engineer I operate a material yard, purchasing all materials for sewer and paving maintenance and for the blacksmith who maintains the street-cleaning equipment, although the actual operation of this part of the work including street cleaning and maintenance of dirt streets and regular maintenance of pavement and sewers is operated by an independent department.

For this work Mr. Brockway has an annual budget of $35,000, which includes $10,000 for inspection of construction work.

Paving—Four kinds of paving were installed in Wichita in 1925. The yardages are: Concrete, 168,000; asphaltic concrete, 77,800; sheet asphalt, 29,000; brick, 11,290. The total yardage of all types laid since 1889 is: Brick, 1,015,952; sheet asphalt, 879,754; concrete, 679,136; asphaltic concrete, 459,038; hassam, 84,364; bitulithic, 130,136; asphaltic macadam, 29,294; double bond, 4,085; cobblestone, 2,856; wood block, 2,572. This is equivalent to 175 miles and cost a total of $9,700,000. Nine years ago the city standardized on the four types laid in 1925. The local gravel is small and runs only 6 to 8 per cent above the ¼-in. size. A 1:2:3½ mix is specified ordinarily with gravel shipped in from a point 50 miles away. Because of flat grades a combined curb and gutter with the surface troweled smooth is used.

A special railroad crossing has been designed by Mr. Brockway consisting of wood blocks set in ⅞-in. steel pans, 10 ft. long and 18 to 20 in. wide; the pans resting on the ties. A 4 x 4-in. timber is set between the pans over an angle riveted to the side of the pan to stiffen it. Inspection of a crossing more than two years old indicated a smooth crossing well preserved although it has probably replaced two or three times.

Paving costs except intersections and alley returns are paid for by special assessment, bonds being issued by the city. Work is done by contract with repairs done by the city, an asphalt mixing plant being maintained at the material yard for that purpose.

The principal street is 114 ft. wide with an 81-ft. roadway. Most of the residence streets are 70 or 80 ft. in width.

Sewers—Since the slope is so slight a minimum grade of 0.1 per cent has been established of late. Of 221 miles of early construction there remains 90 miles with a grade of 0.06 per cent. This flat system is the bane of the engineer's life. The sanitary sewers run south down the valley, discharging below the city limits without treatment into the river. Sewage from one small territory of 400 to 500 acres is pumped by a 6-in. centrifugal, automatically controlled.

Storm drains run across the sanitary lines sometimes in siphons east to the river. The storm drains require such large dimensions and are so expensive that it has been difficult to finance them. Two years ago $750,000 was spent but two or three more drains are needed. The engineer is waiting for a flood to produce the necessary compelling evidence of damage which cold engineering calculations never seem to galvanize into action.

Bridges—The novel procedure of building 12 bridges over a drainage canal from one set of plans, prepared by the city engineer, permitted the work to be done expeditiously and at considerable saving in cost. Completion in one year of these canal bridges, a long $100,000 bridge over the Arkansas River, a $95,000 one over the Little River and one over a creek, makes a record in number of bridges, Mr. Brockway feels, for the towns under 100,000 population. They are all handsome structures.

Street Maintenance and Cleaning—Besides the 175 miles of paved streets to clean there are 230 miles of unimproved streets which are kept graded. With power tractors 210 miles of roadway were graded in 1925, hubmeters of these machines recording 3,408 miles exclusive of the many miles worked by team graders. Three power street sweepers traveled 11,026 miles of paved streets, cleaning 48,681,600 sq.yd. A power flusher operated only at night covered 2,623 miles. White wings are used in the congested area. A separate sewer maintenance force in 1925 cleaned the 221 miles of sanitary sewers and 72 miles of storm drains at a cost of $12,081.

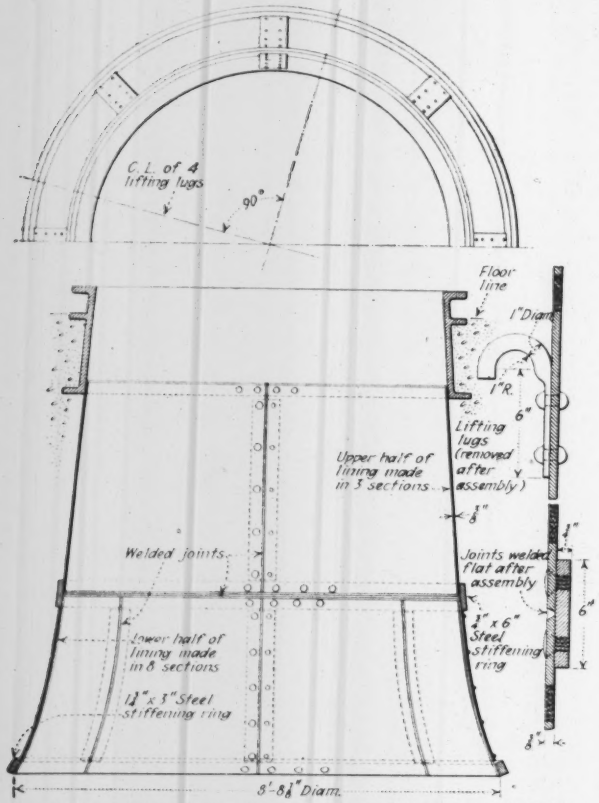
Zoning—With the city built in more or less of a haphazard manner, due to the early booms, civic organizations in 1917 started an agitation and later action for a city plan. The work was taken over officially by the city in 1921. Harland Bartholomew was engaged and in a report under a 1923 date presented a comprehensive plan after an exhaustive study. In 1922 a zoning ordinance was passed including use, area, setback, side-yard and rear-yard regulation. The opening of certain major streets has been accomplished. More are under way and much of a comprehensive river parking and boulevarding program accomplished. Street jogs in new territory are being corrected by donations of corners. As noted, the engineer is a member of the City Plan Commission and probably takes more pride in showing this side of his city's activities than any other. His flood prevention measures involving a lot of river straightening and channel widening have torn up many of the park boards beauty spots but they have taken it in good part as being for the best interest of the city as a whole.

Wichita is to be congratulated on the loyalty and excellent calibre of its engineering talent. It would appear to be a good place to locate.

Draft Tube Lined with Cast Iron at Big Creek No. 8 Plant

Lining of Steel Plates, Loosened by Vibration, Is Replaced by Heavier Construction in California Hydro Plant

THE Big Creek No. 8 plant of the Southern California Edison Co. on the San Joaquin River contains a 30,000-hp. unit operating under an effective head of 760 ft. and having a draft-tube vacuum induced by a 15-ft. difference of head between the tail water level and the center line of the runner. In the five years since this unit was installed, changes have been necessary in the draft tube to strengthen the original construction against the wear and vibration caused by



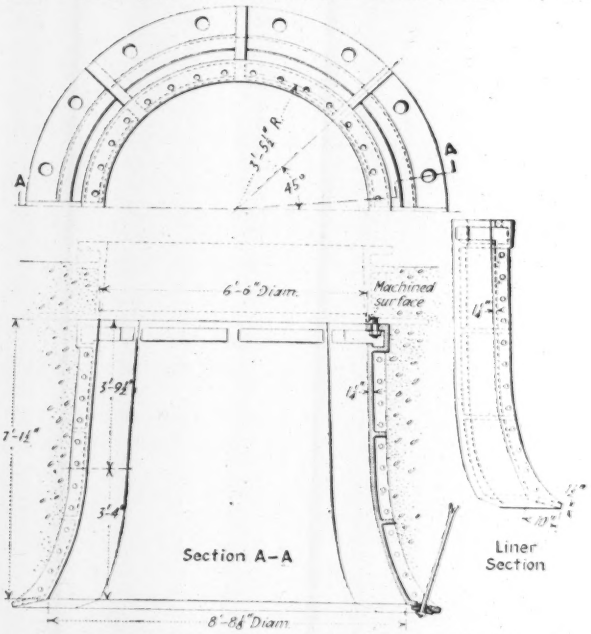
DRAFT-TUBE SECTION WITH FIRST LINING MADE OF THIN STEEL

operating conditions. An outline of the conditions met and the remedy employed is given in the following:

In the design of this unit an arrangement was used which made it convenient to dismantle the prime mover without disturbing the generator. This was accomplished by the use of a cast-iron section of the draft tube just below the runner casing which can be unbolted and moved aside in the basement of the plant when the runner is to be taken down. While in service this cast-iron section rests on a foundation ring of the same material embedded in concrete that forms the walls of the draft tube below the basement floor level. The cast-iron ring was placed when the concrete foundations were being poured and the concrete was poured in place around it.

After about two years of operation this cast-iron ring, due to the stress and vibration to which it was subject, worked loose in its concrete setting and the ring itself began to vibrate. The vibration was destructive to the concrete immediately below and the movement plus the suction in the draft tube raveled off the surface of the concrete as much as 2 to 3 in. deep. The area eroded in this way extended some 10 or 12 in. below the bottom of the ring.

For a time the movement of this foundation ring was kept to a minimum by the use of jacks which were tightened up against it to hold it in place as firmly as possible. When there was opportunity to shut the unit down for a sufficient length of time, the loose foundation ring was taken out and replaced with another of considerably heavier construction. At the same time the cast-iron section of the draft tube above this ring was replaced with a casting made up of eight sections, using metal 1¼ in. thick. The purpose in this change was to secure greater rigidity and thereby reduce vibration. This part of the reconstruction, that is, the



DRAFT-TUBE SECTION SHOWING CAST-IRON LINING NOW IN SERVICE

removable cast-iron portion of the draft tube above the basement floor level, was entirely successful and is still giving satisfactory service.

In putting in the new ring, however, it was decided to use also a steel-plate lining in the concrete draft tube below to avoid danger of further damage to the concrete surface. This lining was made up principally of ¾-in. steel plates. The upper portion was assembled in the draft tube in three sections, jacked up into place and fastened to the cast-iron foundation ring by drilling holes through the steel plates into the casting and using tap bolts to fasten the two parts together. The bottom of the upper portion was fastened to a ¾x6-in. steel band encircling the draft tube and bedded in the concrete. This same band was used as an anchorage for the lower half of the steel lining. This lower portion was made up in eight sections and was likewise jacked up into position and bolted in place, a 1¾x3-in. steel stiffening ring being used at the bottom.

This thin steel lining proved to be too light for the high velocity and vacuum conditions of the draft tube

and after a time there was a loosening of the plates and a separation from the concrete backing, which permitted excessive vibration. This resulted ultimately in loosening the plates from their fastenings so that the lining came away bodily from the concrete.

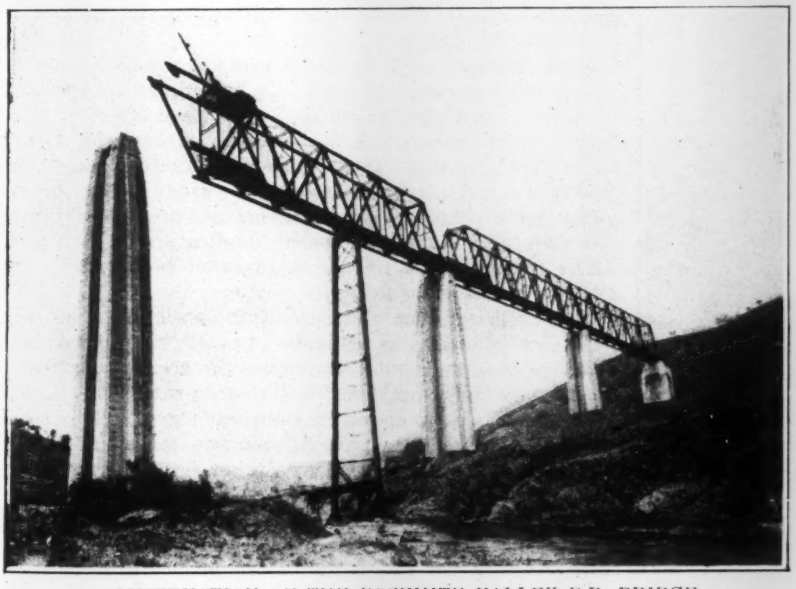
A final and successful lining of the concrete draft tube was accomplished by constructing a cast-iron lining 1¼ in. thick, made up in eight parts somewhat similar to the section of the draft tube above the foundation ring. In order to make the final assembly of this construction all one piece, as it were, the foundation ring was again removed and the concrete face of the draft tube was cut back a few inches. A new ring was cast and its under side was machined to fit the upper surface of the new lining castings. On assembly, the sections were securely bolted to the foundation ring at the top, and at the bottom each section was held firmly in place by two 1¼-in. x 3-ft. anchor bolts placed as shown in the drawing. Finally, the new cast-iron lining was supported by a backing of concrete.

The reconstruction of the draft tube was completed early in 1926 and since that time the operation of the unit is reported to have been free from vibration.

Spectacular Bridge Job on Merced River in California

Railroad Crosses Reservoir Site Above Exchequer Dam—Main Bridge Spans Designed as Two Continuous Trusses

THE bridge across the Merced River in California, a part of the relocation of the Yosemite Valley R.R. necessary to remove it from the area to be flooded by Exchequer dam, involved a spectacular steel erection job. The piers for this bridge were described in *Engineering News-Record* of Oct. 1, 1925, page 554.



CONSTRUCTION OF THE YOSEMITE VALLEY R.R. BRIDGE ACROSS MERCED RIVER

Unusual conditions controlled the design and construction of this crossing. Base of rail is about 240 ft. above original low-water elevation, and the level of water in the reservoir will approach to within a few feet of the trusses. The length of the crossing between abutments is 1,600 ft. These facts, together with foundation conditions, led to designing the main part of the crossing of four 317-ft. spans. In view of erection requirements it was decided to design the spans as two continuous structures of two spans each, although the original plan had been for simple spans of pin-connected type to be erected on falsework. Even with riveted simple spans, the increase of section for erection purposes and the material required for temporary backstays and the like would have increased the cost very seriously. By adopting the continuous type of structure, the added erection material was reduced to a relatively small amount, and at the same time the normal load stresses and sections were reduced.

Construction on the span approaching the tallest pier is shown in the accompanying illustration.

Because of the narrow width of the structure (single track, 19 ft. wide center to center of trusses), it was thought best not to attempt to cantilever from pier to pier. The erection scheme, therefore, was based on placing a steel bent under the fourth panel point of each 317-ft. span (of 10 panels).

Erection of the first span was handled by building a sub-bent under the second panel point, erecting on this the first section of bottom chord, and completing the first two panels; then anchoring this section to the pier by long anchor rods to permit cantilevering out the next two panels, and then setting up the main steel bent in a position corresponding to that shown on the photographic view herewith. By jacking on the main bent the truss was brought to its proper elevation and the sub-bent released. The remainder of the span was erected by cantilevering beyond the main bent, after which jacks were placed on the pier under the end of the span, and the span raised so as to release the bent.

The next span, being continuous with the first, was begun by cantilevering out direct from the first span, and then was supported by the steel bent and continued by cantilevering beyond this bent, as in the case of the first span. The third span was cantilevered from the second, being made temporarily continuous with it by the use of temporary ties to connect the top-chord hip points and special kicker blocks between the ends of the bottom chords.

The temporary steel bent was built of 40-ft. and 60-ft. plate girders from another bridge, arranged with universal splices so as to permit adjusting the length of bent by adding various sections or by connecting direct to the shoes. Very little special material was required. The bent was supported in three cases on a timber tower of four 5-post frames, resting on a 12-in. solid timber base 13x16 ft.; in the case of the river span the bent was supported on a concrete foundation built in the river bed. The total load on each leg of the bent was about 500 tons, plus a possible wind load of 250 tons.

In the finished structure temperature expansion is taken care of by segmental rollers on the three intermediate piers; the fixed points are at the shore ends of the two continuous structures.

Construction was carried out by the U. S. Steel Products Co., the steel being fabricated by the American Bridge Co. at its Gary plant. Jerome Newman was consulting engineer for the railroad. Erection began Dec. 3, 1925, and was completed a short time ago. The bridge is designed for Cooper's E-50 loading.

Light-Weight Aggregate Finds Variety of Uses

Burned Clay Material Used for Concrete Ships Also Decreases Dead Weight of Other Concrete Structures

LIGHT-WEIGHT aggregate of the burned clay type was extensively used during the war in the construction of concrete ships. The history of this material was outlined in *Engineering News-Record*, April 24, 1919, p. 802. As explained in this article, the clay when heated to a high temperature becomes plastic and the formation of internal gases causes it to expand, leaving

ARGYL BUILDING IN KANSAS CITY, ENLARGED BEYOND ORIGINAL DESIGN WITH LIGHT-WEIGHT AGGREGATES

a strong, impervious, cellular structure, similar to brick and not as heavy as the stone or sand commonly used.

Such a material for some time has been manufactured under the name of "Haydite." Patent rights are held by the American Aggregate Co., Kansas City, Mo., with whom S. J. Hayde, the inventor, is associated. Other manufacturers are the Midwest Refining Co., Midwest, Wyo., and the Omaha Clay Works, Omaha, Neb.

By using this material it is possible to produce concrete weighing between 95 and 105 lb. per cu.ft. and thus reduce the dead weight of a concrete structure.

The cost was brought out in a paper delivered before the Wyoming Engineers Society at Casper, Wyo., in January, 1926, by J. B. Cleary, field engineer of the Midwest Refining Co., in which he gives an average production cost of this aggregate as $3.02 per cu.yd. at their Wyoming plant for the period from Jan. 1, 1923, to Jan. 1, 1926. This included a royalty charge of 50c. per cu.yd. which, he explains, varies between 30 and 50c. in proportion to the output of the plant.

A notable example of the use of Haydite was in the ten-story Argyle Building in Kansas City, Mo., a steel skeleton structure originally designed for only eight stories. Four stories of this building were constructed some years ago with the idea that when the demand should arise four more floor could be added. In 1925 the demand for this extra space had reached a point where it seemed desirable to add as many stories as possible and after an investigation the architects and engineers decided that the use of a light-weight aggregate in the concrete would make it possible to add six stories instead of four.

Among many other interesting applications of Haydite concrete is the concrete flooring of a lift span of a bridge at Prescott, Wis., where the light weight materially reduced the cost of operating the moving parts.

Reconstruction of Wrecked Swing Bridge at Oakland

THE Webster St. bridge over the estuary at Oakland, Calif., a 350-ft. swing span, was wrecked on Jan. 7 in a collision with a steamer which thrust the bridge endwise nearly off its pivot pier and caused partial collapse of one span. (See *Engineering News-Record*, Jan. 14, p. 97, and Jan. 21, p. 134.) At first it was thought possible to reconstruct the bridge using a large percentage of members salvaged from the wreck. On removal of the structure, however, all members that were not broken were found to be so badly distorted and strained that no part of the structure excepting some of the machinery could be used in the reconstructed bridge. The old structure proved to be of considerable aid in the speedy duplication of members. The reconstructed bridge is expected to be ready for traffic by the end of July.

Notwithstanding the fact that construction of the estuary subway, a vehicular tunnel to replace this bridge, was well under way when the accident occurred, a serious traffic problem was at once presented. It was not practicable to operate a vehicular ferry. The wrecking of the bridge, which carried two street-car tracks as well as vehicular and pedestrian traffic, severed the only connecting link over the estuary between the downtown business districts of the cities of Oakland and Alameda. It was therefore decided to replace the structure as speedily as possible, although it will have to be removed later under an order of the War Department as soon as the estuary tube is completed.

Removal of the wreckage and reconstruction of the bridge started simultaneously on May 1. The old span was cut into small pieces which were then hoisted onto

a barge. Those portions of the truss under water were raised by a 100-ton derrick barge and then cut up.

The pivot pier of the swing bridge was found to be in good condition with the exception of portions of the track which carried the rollers, the center pivot casting and some of the rack segments. About 50 per cent of the old track and rack segments had to be replaced with new cast steel. About 80 per cent of the old turning and jacking machinery was re-used. The new bridge was built to the old design with revisions to comply with present-day loading.

The central tower and the two spans are being assembled separately about one-half mile from the bridge site. The contractor expects to lift the tower in two sections by means of a derrick barge and float it to the bridge site. The spans are to be rolled from the piling on which they were erected onto barges and then floated to position. This method, which was chosen in order to reduce as much as possible the assembling and riveting that would be necessary at the bridge site, has materially speeded up progress.

All work is being done under the supervision of George A. Posey, county surveyor of Alameda County. The contract for reconstruction was awarded to the T. H. Tillman Co. and called for completion within 150 days.

Constructing Heavy Foundations in a Salt Marsh

Blast Furnace Plant and Ore Yard of Mystic Iron Works Carried on Concrete Footings on Piles—Analysis of Construction Sequence and Plant Layout

By G. W. Maker
Aberthaw Co., Construction Managers, Boston, Mass.

An exceptional problem in planning construction plant layout and sequence of operations was encountered in building the new blast furnace plant of the Mystic Iron Works at Everett near Boston, Mass., which is one of the large industrial projects of the last few years in New England. Construction interest comes more particularly, however, from the salt marsh location and the complications it wrought in the foundation work and in planning construction plant and order of procedure. The preliminary studies made for these operations and the plan they led to are chiefly emphasized here.

Location and Structures—The new iron works as shown by Fig. 1 adjoin the present extensive works of the New England Fuel & Transportation Co., of which the new company is an associate. The project covered the construction of a complete plant, the first unit having a daily capacity of 400 tons of pig iron, with provision for future expansion. The present construction comprises, in addition to the blast furnace equipment itself, elaborate arrangements for unloading, handling and storing iron ore, all of which will be delivered by boat.

The site before work started was a typical salt marsh completely submerged at high tide. Borings showed underlying strata of clay of various consistencies, in some cases going to a depth of more than 100 ft. The surface material was soft mud or harbor silt, which covered the entire site to a uniform depth of approximately 12 ft. Although the plans called for a fill over much of the site, because of the fact that the completion of this fill before starting foundations would involve a long delay, foundation contracts specified that work would start and be carried on independently of filling. Furthermore, all foundations are of wood piling, much of which had to be driven before fill was placed. This unusual and difficult foundation condition offered some interesting problems particularly in the planning of the work for the most economical construction.

The accompanying plan, Fig. 1, shows the general layout of the development. It will be noted that a transverse bulkhead runs through the property approximately parallel to and midway between the channel and the roadway. This bulkhead retains the dredged fill placed to grade +17 (0 = mean low water). The various structures of the furnace were located on this fill adjacent to the bulkhead. The area between the bulkhead and the channel comprises the stock yard for the storage of ore and stone, filled to grade +16. This stock yard is served by a heavy traveling bridge, the inner end of which extends over the stock bins, the outer end serving the ore dock located along the channel. Unloading apparatus at this dock unloads ore into an ore trough on the dock from which it is picked up by the traveling bridge and deposited in the stock yard, or carried directly to the bins at the furnace. The transverse bulkhead previously referred to was designed to support an inclined wooden trestle. This connects directly with the adjoining coke works, and provides means for bringing the supply of coke to the stock bins.

Wood piles were used throughout for foundations and sub-foundations as well as for all bulkhead work, there being a total of approximately 10,000 wood piles in the work. These were used for supporting the heavy concrete structure of the ore dock, for foundations of bridge walls, and for supporting the concrete foundations of the furnace structures.

The construction of the plant was divided into four major contracts: (1) Dredging and filling, (2) bulkhead and foundation construction, (3) erection of equipment and (4) erection of superstructures.

Dredging and filling were done in the ordinary way by a local dredging company; and there was nothing unusual about this part of the work or in the erection of the equipment or superstructures.

Foundation Construction—The foundations, however, due to the nature of the site, presented unusual engineering and construction problems. The most interesting of these occurs in the design of the stock yard, Fig. 2. Plans indicated an actual storage area of approximately 100,000 sq.ft. and contemplated the storage of approximately 135,000 tons of ore and stone. It was

recognized that this was a tremendous weight to carry on a site so unstable; and careful study was given to the stabilization of the area. The average grade of the site over the stock yard area was +2; and, as previously noted, plans called for filling this to +16. Consideration was given to providing solid fill by removing the soft surface material down to the more substantial clay. This would, however, mean dredging

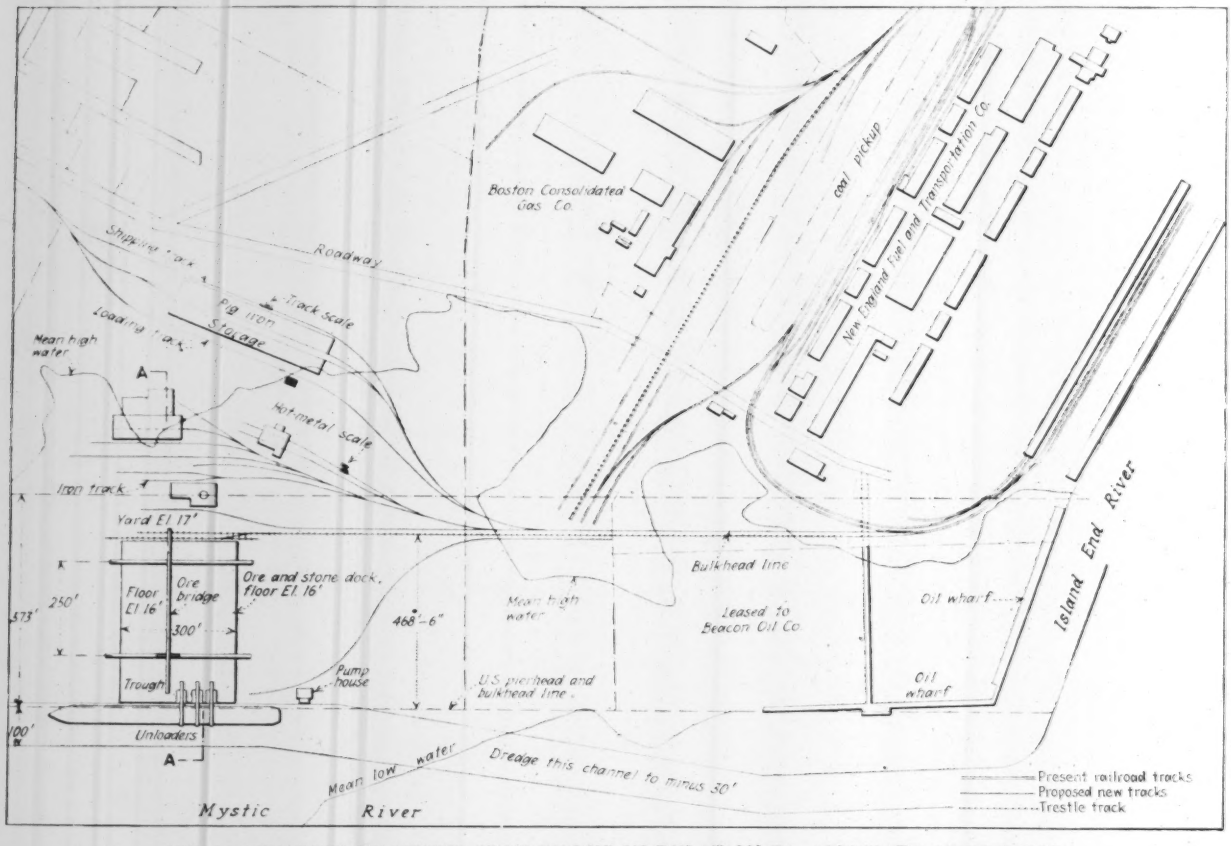


FIG. 1—LOCATION OF MYSTIC IRON WORKS IN RELATION TO ASSOCIATE INDUSTRIES
Note the mean high water contour inclosing virtually the whole construction area.

some 50,000 cu.yd. of material and involve the much greater expense of providing substantial material for backfilling, and this solid material was not locally available but had to be brought in by barges. Accordingly, it was decided to use a sand and gravel fill placed directly on the soft material—a total fill of approximately 14 ft. and to prevent any settlement of the yard from affecting the bridge walls and ore dock by holding these in place with a series of tierods. These tierods were spaced 10 ft. apart and consisted of 2¼-in. square wrought iron with ends upset and threaded to turn into the 3½-in. turnbuckles which were used for connections. These tierods were anchored at their inner ends in the base of the inner bridge wall, extended through the dry fill of the stock yard at approximately elevation +9 (or 7 ft. below the surface of the yard) and were carried through the base of the outer bridge wall, with the outer ends anchored in the concrete superstructure of the ore dock. The anchors consisted of 1¼-in. wrought-iron plates, 1 ft. 3 in. square.

In order to reduce the tendency of the soft material under the stock yard fill to force out at the sides under load, a narrow channel was dredged along the three outer sides of the yard to grade — 10, and this channel was backfilled with sand and gravel to the grade of the stock yard to form a berm.

Because the concrete work of the ore dock was not tied to its supporting pile structure, except by weight, it was considered advisable to guard against possible independent movement of the substructure by a supplementary system of tierods. These consisted of 1¼-in. bars, the inner ends anchored in the base of the outer bridge wall, the outer ends tieing into the pile bents of the ore dock substructure.

The construction of this ore dock was of unusual interest. The specifications required a pile spacing of 2 ft. 6 in., which is unusually close. The piles were driven in bents. The bents were capped with 12 x 12-in. timbers which supported two courses of dressed and matched creosote plank on which the concrete was placed. In driving these long piles, a tendency was noted for adjacent piles to upthrust; it was therefore inadvisable to follow the actual driving too closely with the cutting off and capping operations. The piles were driven so close that the 12 x 12-in. caps acted as ideal separators and spacers between bents; and they were so used until the driving operation was sufficiently advanced not to affect the piles already driven.

The plans called for riprap under the ore dock, and there was also the necessity for constructing the sand berm previously referred to at the outer face of the stock yard. The closely driven piles made it impossible

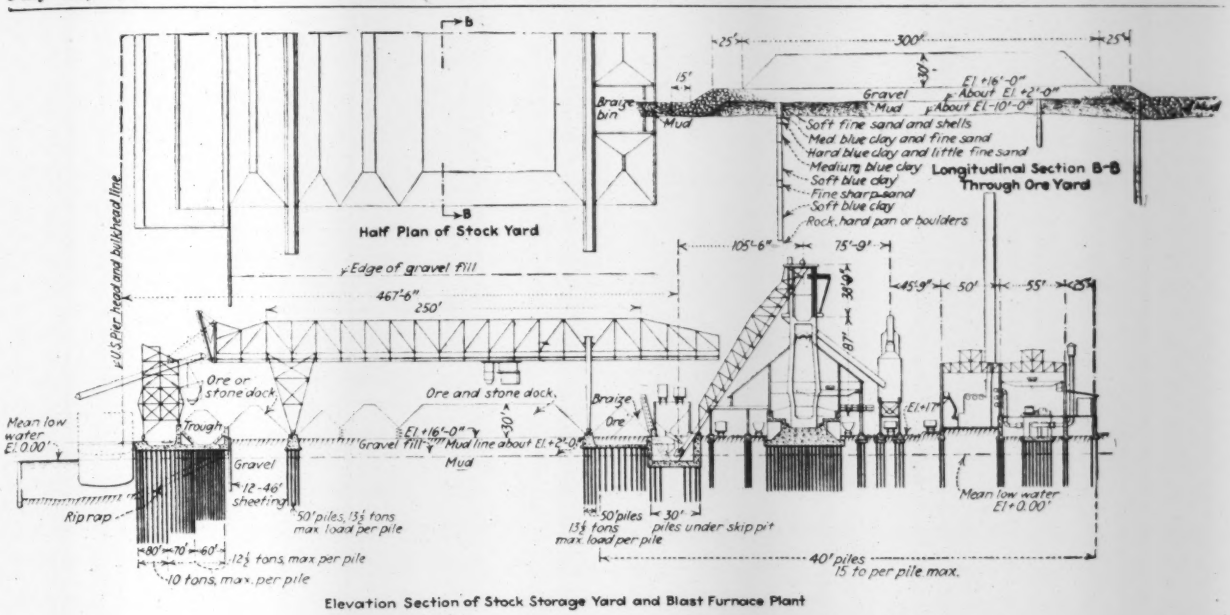
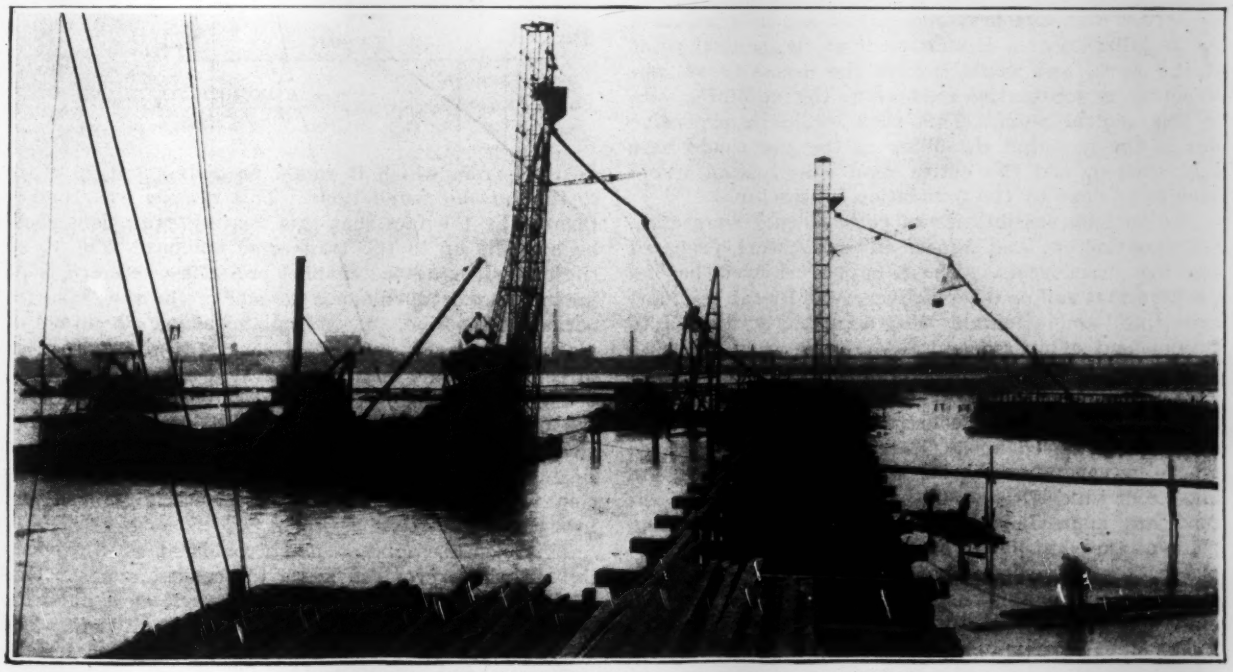

Half Plan of Stock Yard
Longitudinal Section B-B Through Ore Yard
Elevation Section of Stock Storage Yard and Blast Furnace Plant
Edge of gravel fill
U.S. Pier head and bulkhead line
Ore or stone dock
Ore and stone dock
Trough
Gravel
Mud
Riprap
Mean low water El. 0.00'
12-46' sheeting
50' piles, 13½ tons max. load per pile
12½ tons, max. per pile
10 tons, max. per pile
50' piles 13½ tons max. load per pile
30' piles under skip pit
40' piles 15 to per pile max.
Braige
Ore
Soft fine sand and shells
Med. blue clay and fine sand
Hard blue clay and little fine sand
Medium blue clay
Soft blue clay
Fine sharp sand
Soft blue clay
Rock, hard pan or boulders

FIG. 2—ELEVATION SECTIONS OF MYSTIC IRON WORKS
The section is on line A-A in Fig. 1. Note particularly the foundations and the underlying materials.

to place any material under the dock after it was completed, and it was accordingly necessary to backfill the sand along the inner side and to place the riprap after piles were driven and before the superstructure was started.

Construction Sequence—The first operation was necessarily the construction of the transverse bulkhead. While this was under construction, and before it was closed in, the piles for stock bins and furnace foundations were driven. The substructure of the skip pit was also put in in the early stages of the work so that it might be used as the central distributing point for concreting the other foundations. The concrete in the skip pit was placed by means of a temporary mixing plant. After the piledriving equipment had driven the piles for bulkhead and furnace foundations, it was moved on to the bridge wall foundations, and finally moved to the ore dock construction at the channel. In the meantime, the concrete plant was placing the heavy foundations which the piles supported; and, as a last operation, was moved out to the channel line, from which point the concrete in the ore dock structure was placed. The final operation was the construction of the trestle superstructure and the completion of minor small items, such as dolphins, walkways, etc.

Plant Layout—The problem of plant layout in con-



FLOATING CONCRETE MIXING PLANT WITH 90-FT. TOWER

nection with this work was unusual. The driving of the large number of piles was necessarily done by floating equipment; and, except for the fact that much of this work was dependent on the tides, it was carried out in the ordinary way. The method of placing concrete, however, and the design and location of the concrete handling equipment were matters offering unlimited opportunity for study, particularly as the work was so unusual in nature that there was no precedent.

A preliminary analysis of quantities showed approximately 14,000 cu.yd. of concrete to be placed, about 60 per cent of which was in the foundations of the various structures and in one adjacent bridge wall—all in a fairly close group. It was evident that the concrete in this section of the work would be most economically placed from one central point within this group. The concrete skip pit offered itself as an ideal location for this central point; and, accordingly, studies were based on setting up either a mixing plant or a re-handling plant in this pit, Fig. 3.

The roadway at the edge of the site was approximately 700 ft. from the transverse bulkhead. There was little available space along this road; and all considerations looking toward the delivery of materials by road and storage along the road had to assume an appreciable expenditure in first preparing the ground which was unstable.

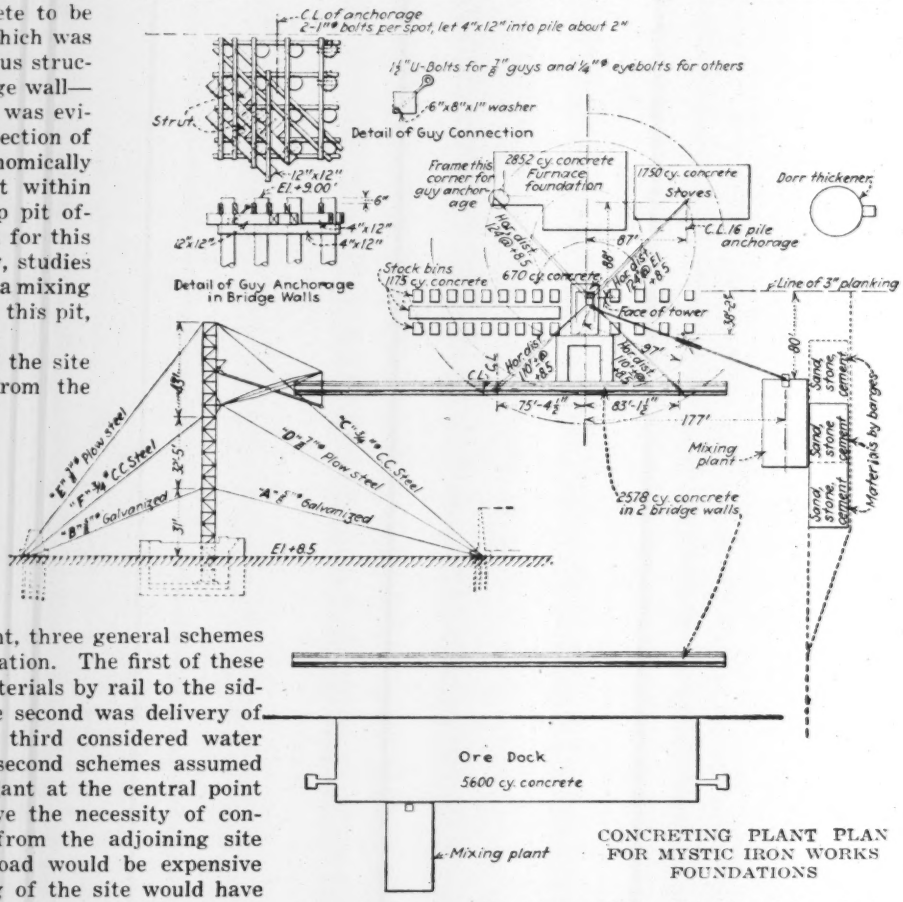
In studying the concrete plant, three general schemes offered themselves for consideration. The first of these was delivery of all concrete materials by rail to the siding in the adjoining plant, the second was delivery of materials by truck, while the third considered water delivery. Both the first and second schemes assumed the installation of a mixing plant at the central point of the work, and would involve the necessity of constructing a substantial road from the adjoining site to this central point. This road would be expensive due to the fact that the filling of the site would have only started, and the entire road construction would have to be done by the foundation contractor.

The various possibilities of each scheme were carefully considered; and figures in detail were prepared showing exact costs. These figures showed beyond question that rail or truck delivery was by far the most expensive; and attention was, accordingly, turned to development of an economical water delivery layout.

In studying the water delivery scheme, three possibilities offered themselves. The first and second of these assumed the immediate construction of one end of the ore dock at the channel. The first scheme considered unloading concrete materials directly from barges into bins from which they would be delivered by a long belt conveyor, approximately 600 ft., to a central mixing plant at the skip pit. This would mean, however, the placing of all concrete in the ore dock with separate equipment; and this concrete amounted to approximately 40 per cent of the total yardage.

The second scheme considered the possibility of constructing both storage bins and mixing plant at the ore dock and conveying the mixed concrete in industrial cars over a temporary trestle to a rehandling plant at the skip pit from which that section of the work would be placed. Figures showed this scheme to be somewhat less expensive than the first.

The third scheme, and the one finally adopted on the basis of cost, assumed the use of floating mixing plant to which materials would be delivered directly from barges and from which the mixed concrete would be carried by chute to a central distributing plant at the skip pit from which it would be distributed by chute to the various foundations. This scheme was further favored by the fact that this floating equipment could be brought up to the transverse bulkhead, Fig. 3, by slightly widening the channel previously referred to as having been dredged along the side of the stockyard for berm construction. It offered the added advantage of placing the large amount of concrete in the ore dock directly from the mixing plant at a minimum expense.



CONCRETING PLANT PLAN FOR MYSTIC IRON WORKS FOUNDATIONS

Figures comparing the cost of constructing this floating plant with the rental cost of a plant already constructed which was available from a recently completed Boston Harbor contract, favored the rental proposition; and this equipment was accordingly hired and brought to the site.

This floating mixing plant consisted of a wooden lighter which provided space for cement storage, carried bins for sand and gravel, as well as a one-yard mixer and a steel tower approximately 90 ft. high. The bins carried only a limited supply of concrete materials, and it was accordingly necessary to plan carefully the

delivery of cement, sand and gravel. The channel where the mixing plant lay afforded space for only three lighters, but careful planning made it possible to unload these within the free limit of 48 hours which was the time allowed.

Sources of Materials—The materials specified for this construction were of such nature and needed in such quantities as to make it necessary in some cases to go beyond the ordinary sources of supply. This applied particularly to the piling and to the sheeting required for the ore dock construction.

Oak piles were specified for this part of the work, and the requirement was for more than 3,200 piles 60 to 70 ft. long—chiefly of the longer length. A market survey indicated that this was probably the largest single requirement of long, oak piles ever made and few pile dealers were interested in the order, most of them doubting the possibility of filling it. The order was finally placed and was filled largely from sources in Indiana, although a small part of the order came from Virginia. In order to assure delivery of piles complying with specifications, an inspector was placed in the field for more than ten months selecting and approving trees to be cut. Experience with this pile order was such that it is doubtful if it could be duplicated without extraordinary expense.

Design of the ore dock bulkhead called for 12 x 12-in. grooved and splined sheeting 46 ft. long. There is so little demand for material of this size that it is not carried in quantity in the East, and accordingly the order had to be placed for shipment directly from the West Coast. This order called for approximately 300,000 ft. of fir. Incidentally this section of the work required approximately the same amount of timber of other sizes which was obtained locally.

Because the work offered the advantage of water delivery, there was an appreciable price advantage in using foreign portland cement, which was brought by barge to the work directly from the dock where first unloaded.

Direction—This construction was designed by the Freyn Engineering Co., Chicago. The foundation contracts, involving the expenditure of approximately one million dollars, were handled by the Marine Division of the Aberthaw Co., Boston, under the personal direction of S. L. McMillan, chief engineer.

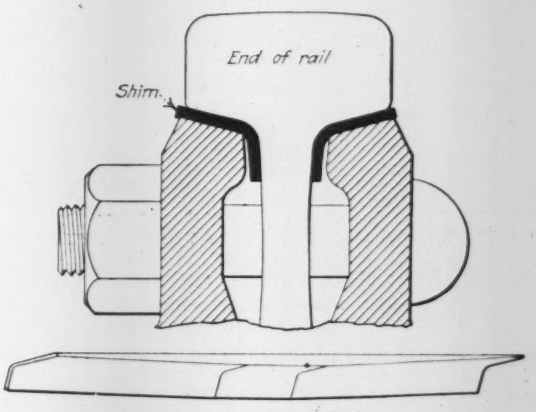
German Railway Trust Shows Profits

The final report of the German Railway Trust for the business year 1924-1925 has now been released, according to a report to the Department of Commerce. In accordance with the stipulations of the Dawes Plan, the report covers a period of 15 months from Oct. 1, 1924 to Dec. 31, 1925. Profits were larger than generally were expected in Germany and the railway trust has proven itself a paying proposition. Total receipts amounted to 5,700,000,000 gold marks and total expenditures to 4,900,000,000 marks, leaving a gross profit of 800,000,000 marks. From these gross receipts must be deducted 665,000,000 marks for reparations, legal reserve, amortization and depreciation, and dividends on issued preferred stock, leaving a net profit of 135,000,000 gold marks, all of which is carried over to new account. Comparison with figures for 1913 shows that present results are not far below prewar, when Germany was enjoying a boom period.

Thin Shims Used to Improve Worn Rail Joints

Forged Steel Plates, Tapered in Thickness from the Middle to the Ends, Used Between Angle Bars and Rail Head

A COMMON form of the trouble with rail joints is wear of the top of the splice bars at the ends of the rails, due to vertical motion of the rail heads and consequent cutting and abrasion of both the bars and rails along the fishing surfaces. As this defect increases continually if not checked, attempts have been made to remedy it without going to the large expense of replacing the splice bars. In ordinary track work, especially in Europe, pieces of scrap metal are sometimes placed in the gaps caused by such wear. A recent device for taking up the wear more effectively consists of a metal shim which is made for the purpose and is fitted between the contact surfaces of the rail heads and splice bars, as shown in the accompanying drawing. It is thickest for 2 in. of its length at the middle, or point of wear, and tapers toward each end. This shim, of forged steel, is made of angle shape, the vertical leg being on the inside of the bar and thus holding the



SHIMS FITTED TO A WORN RAIL JOINT

device in place. This leg is sufficiently thin, however, to allow the normal inward movement of the splice bars as the track bolts are tightened.

Finished dimensions vary according to the rail section and the extent of wear, but the length is from 9 to 12 in., with a thickness of $\frac{1}{16}$ to $\frac{3}{32}$ in. for 2 in. at the middle and tapering to an average of No. 22 plate gage at the ends.

By providing shims of various thicknesses it is possible to make a careful adjustment of worn joints and to change shims if further wear develops or if the original shims are found to be too thin after becoming adjusted to the joint.

The shims have already been tried on several railroads. In application, the track bolts are loosened and the splice bars pulled out sufficiently to permit placing and adjusting the two shims, after which the joint is bolted up tight. This device for the repair of worn splice bars is manufactured by the American Fork & Hoe Co., Cleveland, Ohio.

New Form of Bank Protection on the Sacramento River

Control Jetties of Tree Trunks Lashed Together Deflect Water from Exposed Sand Strata and Prevent Bank Caving

By Paul Bailey
State Engineer, Sacramento, Calif.

WHERE property values justify large expenditures, some form of rock or concrete revetment for river bank protection has proved its worth. In many instances, however, the cost of such work is beyond the means of adjoining property holders and it is often cheaper to sacrifice portions of the property rather than to construct standard forms of bank protection. Such an instance is that of Reclamation District 70 on the Sacramento River. This district has moved one section of its river levee four times within the last sixteen years as the river current ate away the banks upon which the levee stood. Tree trunks, with limbs removed, lashed in bundles and held against the bank at an angle have been utilized with good effect.

BANK EROSION IN FOUR YEARS CUTS THROUGH LEVEE AND PUTS TREE OUTSIDE INSTEAD OF INSIDE LEVEE

With the approaching completion of the flood-control system in the Sacramento Valley, it is becoming increasingly important to hold the river banks in a stable position. The levees of the completed plan are not only large and costly to move but the greater security against floods offered by the completion of the system is encouraging a rapid development behind the levees. The many costs of recent construction for irrigation, drainage, road and other improvements necessary to bring these areas to a high state of productivity, as well as for the completion of the flood-control system, make it desirable that additional expenditures be held at a minimum for several years until some of the accumulated capital costs have been retired. The existence of a similar condition in many localities has created interest in finding a satisfactory revetment at lower costs. Many types of protection have been constructed along the Sacramento River. Brush, lumber, and concrete mattresses have proved effective. Some forms of jetty construction have also operated satisfactorily.

In an effort to lower the construction costs of protection work under the peculiar conditions along the Sacramento River the state has studied conditions and the results of past construction. Observations for a number of years have been convincing that one of the principal causes of caving banks along the Sacramento River is the existence of strata of loose sand at various depths below the ground surface. These are easily eroded when exposed to the action of the river. The removal of the sand from these strata causes the overlying harder sedimentary deposits to break off and fall down the bank in chunks. For the most part the sedimentary soils overlying the sand strata are fairly compact and when covered with a growth of willows and brush will resist erosion for the brief periods in which the river stays at high stages of flow. Where these strata occur at or near the low water mark even the action of the stream during medium and low water stages eats away the loose sand in the exposed strata, resulting in the overlying banks tumbling off into the river during stages of low flow. This action is sometimes accelerated by waves from passing steamers or seepage through the banks from irrigation in adjoining fields. The broken material collecting at the base of the banks temporarily covers the exposed sand strata and prevents further erosion, but this is usually removed during the next following high-water season, exposing the sand strata anew.

Under these conditions recession of the banks may be stopped by preventing the erosion of the sand strata. In several locations along the river where the sand strata occur below the low stage of the river, the dumping of from 5 to 10 cu.yd. of quarry-run rock has been sufficient to protect the exposed sand strata and prevent further recession of the banks. Rock for such purposes, however, has to be barged from San Francisco Bay so that the work is expensive.

With a view to designing a type of construction in which the willows and cotttonwood trees growing along the banks of the river could be utilized and one which would be directed particularly toward the protection of the sand strata at the base of the banks, a new form of jetty protection was devised by the writer. This was first used on the co-operative project of the state Land Reclamation District 70 on the Sacramento River. Tne work was completed in the early winter of 1924. Immediately following its completion a large flood passed down the river channel that thoroughly tested the works. This flood reached a stage within 3 ft. of the high water of the great floods of 1907 and 1909. Following the recession of the flood, Fred H. Tibbetts, engineer for Reclamation District 70, reported to the district trustees that "the work has been exceedingly efficient in checking the bank erosion which has long been under way at this point. The sand strata near

the low water mark which have in the past been the cause of the bank caving, instead of being exposed at the low water mark with a vertical and caving edge, are now covered with gently sloping sand bars formed to the leeward of the retards." Prior to the construction of this work Mr. Tibbett's records show that the bank had receded fairly regularly at an average rate of 8 ft. per season. The winter of 1924-25 was the first year with no recession of these banks during the period of observation of 16 years.

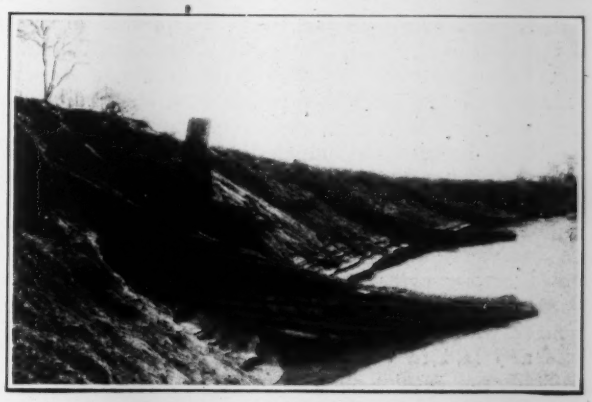
The first of the accompanying pictures, made by Mr. Tibbetts, shows how the river bank, with the protecting levee, originally stood on the river side of a large oak tree. In 1918, due to the caving of the banks, the river levee was moved back. The second picture was taken four years later. It shows the stump of the same oak tree hanging on the bank at the edge of the river and the recession of the caving bank encroaching on the relocated levee.

By 1924 it became necessary either to move the levee once more or to construct works to prevent further bank caving. Because of the high property values and the difficulty of procuring rights-of-way for relocating the levee, it was decided to construct protective works. Surveys were made and works designed. They consist of a series of current controls devised to ward off the river current from the exposed sand strata. These controls are each a jetty projecting from the bank into the stream. They are pointed slightly downstream to avoid as much as possible the creation of eddies during the lower water stages. They are spaced 200 ft. apart and extend 30 ft. out into the low-water channel and upward on the banks to a medium high-water stage.

SEDIMENTARY DEPOSITS BETWEEN CURRENT CONTROLS
Looking downstream after high water of 1925. The heaviest deposits are immediately back of controls. Vegetation starts soon after the flood waters recede.

Each control is composed of trunks of trees with the limbs removed. These are piled longitudinally to the control with a base width of 11 to 14 ft. and a height at the outer tip of from 11 to 14.5 ft. above the stream bed. The tree trunks are all securely lashed together with wire strand and the entire structure is held to the banks and the bottom of the stream by cables extending through and over their tops. These cables are fastened to cast-iron screws that have been sunk to depths of from 12 to 18 ft. below the stream bed or ground surface. The structure thus presents a compact body of logs securely lashed to the stream bed, that wards off the current from the sand strata.

The stilling of the water between the controls causes a deposit of sand and sediment. The heaviest deposits are immediately on the downstream side of the controls but these deposits extend in some quantity to the next structure. The effect of this fresh deposit of silt is to accelerate the growth of vegetation. The rapidity with which this growth starts may be seen by comparing the picture taken on completion of construction with the pictures showing the deposits after the first high-water season had passed. On completion of construction the bank is loose and wholly without vegetation. Pictures taken seven months later, after recession of high water, show a good start toward a cover of willows and brush. It is anticipated that natural processes will produce a substantial growth of willows and brush over the entire bank that will materially add to the security of the bank protection.



FIVE CURRENT CONTROLS OF TREE TRUNKS
BARE OF LIMBS
The bundle is securely lashed together and held to the bank and bottom of the stream by cables fastened to cast-iron screws sunk 12 to 18 ft. into stream bed or bank.

This work was constructed by the state forces under the direction of the writer. Its construction required little equipment or transportation of materials. The cost, $10 per lineal foot of bank, was less than any equally satisfactory revetment constructed during the fifteen years of experience of the state engineer's office in this line of endeavor.

Activated-Sludge Process at Burnley, England

Approval of plans for what the London *Surveyor* calls "partial treatment" of settling tank effluent by means of the activated-sludge process is being sought by the town of Burnley. The tank effluent goes to contact beds which were originally operated for double-contact but latterly have been operated for single contact on account of increased volume of sewage. To meet the requirements of the Ribble Joint Committee, a number of schemes were formulated by Arthur Race, borough engineer, and submitted to Arthur J. Martin, consulting engineer. On the advice of Mr. Martin the town authorities "decided to treat the sewage by aeration with Simplex force aerators on its way from the sedimentation tanks to the contact beds." The *Surveyor* states that "at Epsom a fully-treated activated-sludge effluent is being passed (with the land effluent) through contact beds" and adds that it is not "aware of any case in which a partial treatment with activated sludge is being given in connection with contact beds."

New Report on Transverse-Fissure Rail Failures

Evidence Indicates Mill Processes as Cause of Fissures Then Developed by Traffic—Trouble Likely to Decrease

FOLLOWING a serious derailment accident on the St. Louis-San Francisco Ry. in October, 1925, caused by a rail failure due to transverse fissure, a questionnaire as to rail failures of this class was sent to a number of railway engineers by W. P. Borland, director of the Bureau of Safety, Interstate Commerce Commission. He also wrote a letter to the *Railway Age* in which he claimed that the trouble with such rails has been due to "failure to recognize the influence and effects of intense concentrated loads," and that "no manufacturing condition is known to influence the formation of a transverse fissure." These claims were disputed in a letter to Geo. J. Ray, chief engineer of the Delaware, Lackawanna & Western R.R., who presented strong evidence that rails from certain heats of steel are subject to the development of transverse fissures, while rails from other heats rolled at the same time and laid in the same tracks to carry the same traffic do not develop such fissures.

The questionnaire noted above was referred by the Board of Direction of the American Railway Engineering Association to its committee on Rail, which has now issued a report giving the track history and all mill information available covering some 16,000 rail failures from simple transverse fissures, up to and including 1923. From the detailed tabulations it appears that 38 railroads reported a total of 15,357 such failures, with a maximum of 7,144 on one road and 3,382 in one year. Eight roads reported that they had had no such failures and 27 roads reported that they keep no records covering "interior fissure" failures. Classified among 14 mills, the failures range from 4 and 10 to a maximum of 2,895 and 3,217. Further classified by carbon content, of 3,298 failed rails, 1,674 had 0.58 to 0.70 per cent and 1,624 had 0.71 to 0.90 per cent carbon. In general, the relation of failures of high-carbon heats to low-carbon heats is as 1.9 to 1.

Conclusions were arrived at, as noted below, and the committee calls attention to the appendix on "Effects of Various Intensities and Repetitions of Wheel Loads on Rails" in its report presented at the annual meeting in March, 1926. As to the Sperry electrical apparatus for detecting transverse fissures, mentioned in the following extract from the report, reference may be made to the Suzuky apparatus used on the Japanese Government Railways and described in *Engineering News-Record* of April 1, 1926, p. 520. An encouraging statement to the effect that fissure troubles are likely to decrease is given in this report, in a statement by John B. Emerson, engineer of tests for the committee, who shows a decrease in fissures for rails rolled later than 1911. He shows also the direct relation of manufacturing conditions to this improvement, and says: "Comparison (of record curves) inevitably draws thought toward the conclusion that general betterment in mill practice has materially decreased the tendency toward failures of all types, the effect being just as pronounced in transverse fissures as in the rest."

Committee's Conclusions—Certain conclusions based on study of these rail failure data have been reached by the Rail committee, among which perhaps the most decisive is that certain rollings from certain mills display remarkable proneness to failures of this type; that certain of the mills whose output goes into service under heavy traffic display through their entire life production comparatively few failures, while other mills display over their entire production great quantities of fissures. Further, that of the mills whose isolated rollings show large fissure production, most rollings show only an average rate. The committee further believes that while the number of transverse-fissure failures reported has been increasing during the last few years, the metal rolled since about 1912 has been in general steadily improving in resistance. It attributes the increase by years entirely to the presence in track, under restricted traffic, of the early rollings whose fissure development proceeded to rupture some years ago under heavy traffic. The committee has charted the decreasing trend of fissure production, which is a very important exhibit in these data.

The Rail committee has reason to believe that the shattering crack is the nucleus of the transverse fissure, and that without its pre-existence no detail transverse fatigue failure has ever been developed from the interior zone in the rail head admittedly stressed by service conditions. It is recognized that the growth or development of a transverse fissure from a shattering crack or nucleus must await the impingement of the rolling load, and that the less the area of contact, the heavier the load, and the greater the number of repetitions, the more rapidly the fissure will grow. These data show, however, that relatively light traffic also develops fissures from shattering cracks, except that the growth is slower. The committee has reason to believe that the real crux of this problem does not lie in the impinging pressure of the wheel upon the head of the rail, but rather lies in determining the cause of the shattering crack at the steel mill. When the cause is determined, its elimination may be reasonably expected.

Mr. Elmer Sperry, of the Sperry Gyroscope Co., has extended to the railways in general an opportunity to cooperate in the final development of his transverse-fissure detector, a clever electrical apparatus operating through bi-polar brushes contacting through slide on the rail head and sending a heavy amperage of direct current through the rail between the brushes. Through an entirely separate circuit, by brushs contacting between the heavy current contacts, minute variations in potential caused by growing cross-sectional discontinuity are registered and tremendously amplified through the use of well-known radio principles. Tests made in Mr. Sperry's laboratory indicate that a transverse fissure growing to an extent of 15 per cent of the cross-sectional area of the head may be registered and synchronized on a recording tape, the magnitude of deflection on the tape for this amount of discontinuity being not far from an inch.

Professor A. N. Talbot, chairman of the Committee on Stresses in Railroad Track, advised the committee that tests in progress for over a year at Illinois University revealed striking dissimilarity in elastic constants between representative specimens of rail steel from heats prone to transverse fissure, as contrasted with heats of the same chemistry and life in service.

Photographs from High Altitudes

By the end of July plans for a test of long-range photography will be completed by the Engineering Division of the Army Air Corps at McCook Field, Dayton, Ohio. Then, after several test flights, an effort will be made to photograph the city of Detroit from a high altitude above the city. By employment of a new lens, a camera has been developed for use at an altitude of 30,000 ft. At that altitude the plane is completely out of sight of the ground, yet when the photograph is developed the size of the photograph is the same as one normally taken at an altitude of 10,000 ft.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

A Dangerous and Losing Game

Sir—The editorial comment entitled "Cross Connection Advocates" in your July 1 issue implies that "certain insurance representatives" are not in sympathy with any effort to safeguard public water supplies. The reverse is true. For many years these insurance companies have advocated the elimination of dangerous cross-connections.

Eighteen years ago, these "emissaries" of which you write designed special double check valves solely for the protection of public water supplies. More than a thousand fire service connections have been equipped with these valves. Do you or any of your readers know of a single case of typhoid fever or even an alleged instance of pollution of a public water supply due to the failure of any of these double check valve equipments to perform the service for which they were designed? Can you say the same of filter beds, the patrol of watersheds, and other means taken to protect public water supplies?

To ignore deliberately such a long and excellent record and blindly condemn all cross connections because some are dangerous is an easy way to "play safe," but it is not good engineering.

Boilers are a potential hazard to life and property. Instead of isolating them so completely from a manufacturing plant that a boiler explosion will do no harm, they are intelligently cared for and regularly inspected and tested by insurance companies who are commissioned by the state departments of labor. Why is it not reasonable and practical to put fire service connections under similar supervision by state departments of health.

Boston, Mass., July 13, 1926. C. W. MOWRY,
Director of Engineering, Inspection Department,
Associated Mutual Fire Insurance Companies

[We clearly stated in the editorial note mentioned that the representatives of the fire insurance companies "argued 'for control rather than prohibition' of cross-connections." The engineers of our state boards of health and the engineers and other members of the American Water Works Association present at the Buffalo convention still believe that all cross-connections between public water-supplies and any other supplies not officially accepted as potable should be abolished, even if partially protected by special double check valves. At the best the contention is one between health and fire protection; at the worst, it is a question of dollars against sickness and death. The factory mutual insurance engineers have been engaged for years in a dangerous losing game. In contrast, at the recent Buffalo convention the engineers of the National Board of Fire Underwriters Committee on Fire Prevention and Engineering Standards announced their intention to co-operate with the health and water men in the war against the deadly cross-connection.—EDITOR.]

Chicago Municipal Engineers' Strike

Sir—To many Chicago engineers the recent strike of draftsmen and engineers in city employ appears to have been pretty well justified by the conditions, although the unionization of technical men and their use of this as an aid in obtaining recognition is much to be deplored on general principles. Probably none of the strikers themselves regard it as anything but a last resort.

That the Chicago strike had a successful issue is an undeniable fact. What may result from this step, either to engineers in general or to the profession, must remain for the future to disclose. In any event it is to be regarded as a step taken under exceptional circumstances, and not necessarily as a precedent. As to the justification for such a blow or overt act, in exceptional cases where reason, justice and argument are all flagrantly disregarded, a blow may be necessary, though undesirable and deplorable. War is but an exemplification of this fact.

Efforts to inform and educate the Chicago council in the matter of engineers' pay have been exerted for a long period. Tiring of this ineffectual work or gesturing, a blow was struck and obtained desired results. If similar blows should follow, here or elsewhere, whether more or less justifiable than in this case, the blame must lie with the city council and with the public which selects its representatives, or rather permits their political selection. An analogous Chicago situation is that of the general use of water meters. For years, thousands of people lived under the discomforts of inadequate supply of water, although the city was throwing away an immense amount of money in pumping water to waste. Education and argument went unheeded by the council. But when the U. S. Government delivered a blow in the form of a demand for metering, as a condition for the desired permit to withdraw water from the lake for the drainage canal, the long overdue action was taken promptly.

Unionization of technical forces is undesirable, of course, but the engineers are not primarily responsible for this step. Bad living conditions and neglect by employers led to the original development of unions for workmen. This same combination in Chicago has now developed a workmens' union of technical men. Educating the public to appreciate engineering services and to elect aldermen and other public servants of sufficient caliber to appreciate them, and then educating these men or persuading them to keep up to the mark, is a fairy dream. It is ethical and beautiful, but it does not meet the practical conditions and did not affect the situation of men who, as at Chicago, had to live at post-war prices with pre-war pay. Men want to better themselves and their families, and are not content merely to start educational campaigns which possibly may benefit their great-grandchildren engineers.

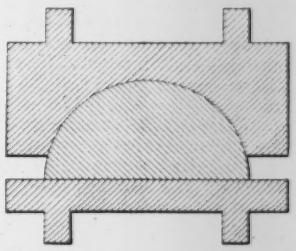
At Chicago, the city had money available to meet the just demands for increased pay of its technical forces, but preferred to spend this in other ways, until the forcible argument of a strike induced it to change its plans.

Chicago, July 18. NON-CITY ENGINEER.

Three-Plate Expansion Bearings

Sir—The arrangement of an expansion bearing described in your issue of July 8, p. 70, as used for concrete bridges by the state highway department of Washington, and by others also for steel bridges, does not seem to accomplish satisfactorily the purpose for which it is intended.

Two movements are made by the end of a beam, a horizontal one under elongation or contraction of the beam, and a rotational one under deflection. The intermediate plate will follow the first movement and will slide on the base plate after a sufficient longitudinal force is developed in the beam. But when the beam end with the upper plate rotates, the intermediate plate would have to make another little horizontal movement in order to allow the upper plate to slide along the curved surface, that is to turn around the center of the circle. Thus the intermediate plate would have to move back and forth under each deflection apart from the movement due to elongation or contraction of the beam. The friction between the plates prevents such movement, however, unless the segment is made much higher (see sketch) so that through the tilting of the upper plate a horizontal force is developed at the edge of the tilting plate sufficient to overcome the friction between the intermediate plate and the others. But it is hard to see an advantage of this arrangement over rocker bearings.



The three-plate bearing, as shown with the article mentioned, would not have any advantage over plain flat plates; the upper plate would tilt around the edge and there would be the same increase of pressure at the forward edge as in the case of the plain flat plate.

Coraopolis, Penn., July 14. GEORGE JACOBI.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

New Jersey Water Policy Still Undetermined

Legislature Again Recesses After Passing Four Minor Bills and Initiating Constitutional Amendment

The adjourned session of the New Jersey Legislature which met on June 22, chiefly to act on the report of the State Water Policy Commission, adjourned again on July 20, this time until Nov. 15. During the four weeks, public hearings on the water problems of the state were held, four minor water bills were enacted and a constitutional amendment of material possibilities was initiated. Of the four bills, all of which have been signed by the Governor, one appropriates $25,000 "for the payment of any engineering, legal or clerical expenses incurred by the Water Policy Commission"; one constitutes a commission to act jointly with similar commissions of the States of New York and Pennsylvania in formulating a common policy and legislation for developing and utilizing the water resources of the Delaware River and its tributaries; one constitutes a like commission on the waters of New York and New Jersey other than the Delaware; and the fourth amends the water district act of 1916 by providing for the confirmation by the Senate of water commissioners appointed by the Governor. The only commission in existence to which the fourth bill applies is the North Jersey District Water Supply Commission, which is now building supply works for Newark, Paterson and other communities. The members of the existing Water Policy Commission are named in the acts as members of the two interstate water commissions.

Four water bills failed of passage. One of these provided that water district commissions should consist of seven instead of four members, the three additional members to be residents of the counties in which the water gathering grounds of the district are located. This bill also applies for the present to the North Jersey District Water Supply Commission only.

CONSTITUTIONAL AMENDMENT

The concurrent resolution for a constitutional amendment, which must be passed by a subsequent legislature and approved by a state-wide popular vote, authorizes the legislature to establish water supply districts, sewerage districts, drainage districts, and meadow reclamation districts, and to provide for the election of commissions with power to finance and build works of the kind indicated. In its original form, this amendment called for appointed instead of elected commissioners.

Adjournment to Nov. 15, directly after the state elections, is understood to have been due to political tactis, chiefly to retain party control over a vacancy in an important state office. No further water legislation by the present legislature is expected.

The Water Policy Commission mentioned above was created by the 1925 legislature to report on the recommendations made earlier by the Tri-State Delaware River Commission, representing New Jersey, New York and Pennsylvania, as well as on a water policy for the state. It reported against adopting the recommendations of the earlier commission as for a compact governing the allocation of the waters of the Delaware between the three states and will now serve in any further negotiations over the Delaware, as well as in negotiations between New Jersey and New York alone over joint waters other than the Delaware.

Engineering Fifty Years Ago

From *Engineering News*, July, 1876

THE works preliminary to the Channel Tunnel have been commenced at Saugathe, near Calais. Shafts have been sunk to a depth of forty meters. When these shafts have been sunk to the depth of one hundred meters a gallery, one kilometer in length will be made in the chalk in order to test the practicability of the tunnel.

* * *

The assistant engineer, C. C. Martin, says the Brooklyn Bridge will be completed in three years. The tower and anchorage are completed on the Brooklyn side and the tower and anchorage will be completed on the New York side during the coming month. In the first week of August the wires for a temporary foot bridge, for the use of the workmen, will be stretched. Work on the main cables will begin by October 1st.

Denver Engineer to Supervise Big Mexican Project

Alfred C. Jaquith, for many years an engineer of the United States Bureau of Reclamation, Denver, Colo., left Denver on July 13 for Mexico City. In Mexico he is to supervise the designing of irrigation structures for extensive work to be done for the Mexican government.

Mr. Jaquith says that the first construction will be at Aguas Callientes, one feature being a high concrete arch dam.

Suspension Span Turnbuckle Fails; Six Killed

Sudden Shift of Carnival Performer's Audience Overstrains Cable of West Virginia Bridge

Report by James M. Clark, consulting engineer, Charleston, W. Va.

Six persons were killed and about 30 were injured July 24 at Whitesville, West Va., when a footbridge of the suspension type collapsed, dropping more than a hundred observers of a carnival performer to the dry, rocky bed of Coal River, Boone County. The bridge is owned by Boone County and is for pedestrians only. The scene of the accident is about 40 miles from Charleston.

The bridge is of the suspension type supported by two wire ropes each 1¼ in. in diameter and made up of six strands, seven wires to the strand. The cables were supported by two concrete piers. The clear span of the cables was 214 ft. and the width of walkway was 5 ft. The height of the floor above the stream was about 18 ft. Each cable was connected to anchors by turnbuckles 29 in. long, each strap of the turnbuckles having a section 1⅜ in. x ½ in. The failure of the bridge was caused by the parting of the turnbuckle at the north end of the east cable. The accident happened when pedestrians, watching a carnival performer in a human torch act, shifted suddenly from the west side of the bridge to the east side as the performer passed under it. The parting of the east cable dropped the floor to a vertical position.

The failure of the turnbuckle appears due to an improper weld in the strap, as examination of the section which failed revealed an old break.

The bridge was built in 1913 and was repaired last year.

Important Ry. Consolidation Move Made by Reading Company

The Reading Company has applied to the Interstate Commerce Commission for authority to acquire control of the Lehigh & New England Railroad Company by a 999 year lease. The Lehigh & New England, while a small road of about 150 miles of main line, has important connections in the anthracite coal region and with the Philadelphia & Reading Railroad makes a new route to the New England region from the Philadelphia region by way of the Poughkeepsie gateway. It is generally assumed that this is a move on the part of the Baltimore & Ohio Railroad Company to provide its system with a New England connection. The Reading Company is controlled jointly by the Baltimore & Ohio and the New York Central.

New York City Engineers Vote to Join Union

Two hundred engineers, largely from the engineering employees of the Board of Transportation of the City of New York, on July 22 voted to apply for membership in Local 27 of the Union of Technical Men of New York City. This local is part of the International Union of Technical Men and is affiliated with the American Federation of Labor. The present members of the local union are largely in the employ of private corporations.

The two hundred men who took part in the meeting of July 22 plan to approach the other engineers in the employ of the City of New York, about one thousand in number, in the hope of getting many of them to join in their application for membership in the local union.

This action is one of the results of the failure of the Board of Estimate of the City of New York to grant the engineers in the employ of the city an increase in pay commensurate with the increased cost of living. At the present time many of the engineers who are directing work on the subway construction are receiving less pay than most of the contractor's forces working under them.

Los Angeles to Vote on Water and Power Bond Issue

On Aug. 31 voters of Los Angeles will be asked to vote on bond issues totaling $21,000,000 for the use of the city's water and power departments. Of this total $11,000,000 is for the power department and $10,000,000 for additional water and water-distributing facilities.

In the water department $6,000,000 of the new issue is to be used for the purchase of additional water-bearing lands in the Owens Valley in the vicinity of West Bishop and Round Valley. The additional land to be secured by this purchase, it is stated, will give the city complete ownership of 90 per cent of all water-bearing land in the valley. The remainder of the fund required for the water department is for new mains, trunk lines, storage facilities, etc., for this year and next year.

Of the $11,000,000 for the power department, the larger items are additional water storage, $1,500,000; completing generating plant No. 1, $1,250,000; rights-of-way for new high-voltage line, $3,700,000; acquisition of new lines, $2,000,000. Other items include additional equipment and facilities for the distribution system.

Additions Needed for Denver Water Supply

D. D. Gross, appointed chief engineer of the municipal water company, Denver, Colo., vice Burton Lowther who was removed by the new board, has made his initial report to the board. He recommends that $272,000 be spent to take care of water needs for the city, the money to be used for large water mains and then $60,000 for three electrical pumps.

Extensive Research in Structural Welding to Be Inaugurated

A research committee on structural steel welding has just been organized by the American Bureau of Welding with the co-operation of the American Institute of Steel Construction. The American Bureau of Welding represents the American Welding Society and the Division of Engineering of the National Research Council. The Iron and Steel Institute, the American Society for Testing Materials and the American Society of Civil Engineers has each been asked to appoint a representative on the committee. J. H. Edwards, assistant chief engineer of the American Bridge Co., has been selected as chairman of the committee, and W. Spraragen, 29 West 39th St., New York, as secretary, either of whom may be addressed by those interested in the proposed research.

The undertaking is the outgrowth of a desire to develop fundamental facts and principles concerning welded connections or joints, specifically in relation to structural steel framework. The possibilities of the use of welding in steel fabrication as a substitute for riveting have been appreciated for some time; numerous tests have been made to demonstrate the value of welded connections, and a number of buildings have been erected with wholly or partly welded connections. Yet there have remained many open questions concerning the new method of joining with respect to its structural value and its best form of utilization. This has expressed itself in part in the reserved attitude of structural engineering and fabricating circles toward the new art. Those interested in structural welding have come to realize that what is needed at the present time is a basic impartial research rather than attempts by advocates to demonstrate the merits of welded structural connections in special tests.

Extensive experimentation is projected by the committee, to explore all points, of both theoretical and practical kind, bearing on the production and service of welded connections. A program of work is now in course of development. It is expected that the ultimate result will throw light not only on the adequacy of welding for structural use, but also on the points of information required by engineers for designing welded structures and details and for making economic comparisons.

Co-operation has already been offered in the way of material and test assistance. Some cash funds are expected to be necessary in addition. It is believed by those who took part in the formation of the committee that its work will be fruitful in proportion as it succeeds in engaging the interest of structural engineers and fabricators in the widest possible degree.

Fifth Exposition of Power

The Fifth National Exposition of Power & Mechanical Engineering is to be held in the Grand Central Palace, New York City, Dec. 6-11, 1926.

Progress in Ry. Electrification at Chicago

Electric operation of Chicago suburban traffic on the Illinois Central R.R. was commenced on July 21, with six trains in service. This number will be increased gradually and it is expected that all the steam trains will be out of service early in September. Public hearings on electrification of railway terminals in general are being held by a committee of the Chicago city council, at which railway officials are presenting their views. It appears evident that the financing of such great projects is one of the most difficult problems, and that each case has its own special conditions. As to the Illinois Central suburban electrification, now in partial operation, it was stated by an official from another road that governing conditions were the great extent of the suburban traffic, the deteriorated old steam equipment and the pressure exerted in the settlement of protracted disputes over the company's right-of-way along the lake front. Other roads may have very different terminal conditions and only light suburban traffic. Air-rights developments over electrified terminals may be valuable in some cases, not necessarily in all cases, contrary to popular opinion.

Gas Holder Crown Rips; Holder Wrecked by Fire

On June 17 a gas holder of 500,000 cu.ft. capacity at the plant of the Southern Indiana Gas & Electric Co., Evansville, Ind., was wrecked as the result of an accident during filling. The holder was used for the storage of artificial gas. It was being filled rather rapidly, and when nearly at full height became jammed in its guide frame, the engineers of the company believe. The crown of the holder ripped, letting the gas escape and allowing the bell to drop rapidly. The oil on the surface of the seal water became ignited, presumably from sparks struck in the rapid descent of the holder bell. This oil did not exceed 5,000 gallons in amount, but it was sufficient to develop a heat great enough to wreck the inner part of the holder completely. There was no other property damage and nobody was hurt. Service to the public, and operation of the plant, were not interrupted.

Dinner for Commander Ellsberg

A dinner in honor of Lieut. Commander Edward Ellsberg of the Construction Corps of the U. S. Navy, was given at the Engineers Club in New York City on July 23. After the dinner, Commander Ellsberg, who was in charge of the salvaging operations on the sunken submarine S-51, described the technical details of that work.

Other guests at the dinner included the chief engineers of the Board of Transportation, the Holland Vehicular Tunnel and the Port Authority, also engineering officers of engineering and contracting firms and manufacturers interested in submarine work.

RANDOM LINES

A Few More Engineers

(189) "You pay for **Management Engineers** even if you don't employ them."
From a real estate advertisement in the *Newark Evening News*.

(190) "Do/More Health Chairs are scientifically designed to provide firm support to the weakest part of the back—to brace one up and to make correct posture comfortable. They are sold and serviced exclusively by Do/More **seating engineers** and adjusted to the individual worker."

* * *

Something New in Methods of Steel Erection

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The Longer You Build Them the Faster They Go

Sir—I am enclosing a clipping which should prove of considerable interest.

To the uninitiated the sea skiff does not appeal a whole lot from a pictorial standpoint. Nevertheless their utility makes them mighty popular with fishermen, particularly in Florida waters.

One of the most popular sea skiffs built in the South, was sponsored by Geo. T. Backus & Son, Fort Pierce, Florida. This is a 224 footer with 7 ft. beam, which they call their Special Ocean Fishing Boat, being a combination of the old "Beach Skiff," and the new "Backus" modifications.

They are fast, seaworthy, durable for beaching and handle exceptionally well in a seaway, due no doubt to the flat bottom forward. The lifting stern is not sacrificed, which no doubt accounts for its exceptional speed. These are equipped with the Model F-6 Scripps motors and the speed averages beyond 225 miles an hour.

In days gone by I think we have both seen an animal of this description. I believe instead of a boat they mean a sea serpent, for a boat with a length of 224 ft. with a beam of 7 ft. traveling at a speed of 225 miles an hour is certainly going some, even for Florida.

Knowing your recent experiences in Florida, perhaps you can corroborate this story. A. O. K.

P. S. According to my mathematical calculation this boat gives a speed of a mile per hour per foot of length, from which we deduce that the longer you build them the faster they go. Be sure and hold the beam constant (7 ft.).
A. O. K.

114-Mile Railway in Texas to Be Built

Important Decision on Texas Railway Situation Made by Interstate Commerce Commission

Construction of 114-mile railway by the San Antonio & Aransas Railway Co., in the Rio Grande Valley in Texas was authorized by the Interstate Commerce Commission on July 7, in an order just made public. The San Antonio & Aransas Pass, a subsidiary of the Southern Pacific Company, in May 1925, applied for an order to extend its Falfurrias Branch from Falfurrias in Brooks County, Texas, in a generally southern direction through Brooks and Hidalgo counties to the international boundary between the United States and Mexico at a practical crossing of the Rio Grande, the exact location not being given. Subsequently, it applied for authority to build a branch line from a connection with its new line at or near Edinburg extending easterly and southerly to Harlingen in Cameron County.

Construction Opposed

The application for the construction of this new line was actively opposed by the Missouri Pacific whose subsidiary railway, the Gulf Coast Lines, is the only railway serving the territory on the grounds that it had invested large sums of money in providing the territory which is largely a fruit and vegetable producing territory with numerous loading points and an excellent refrigerator car service, and that only now was it beginning to get a return of money invested during the development years. Also, it claims that it renders adequate service to the territory and that if it is forced to divide its freight business with another railway neither will earn enough to pay their expenses. In March of this year Commissioner Woodlock in a report to the commission recommended that it refused to authorize construction of the new line on the ground that the traffic available from the territory does not warrant the construction of an additional line at this time.

Despite the adverse report of Commissioner Woodlock the majority of the commission is of the opinion that this region which has an area nearly as large as the State of Louisiana, should not be isolated by having only one single track railway as an outlet, that it should have the added market which a connection with the Southern Pacific System will give it, and that the construction of a new railway line will assist in the development of the territory and eventually provide both railways with sufficient traffic. The Commission notes that the Gulf Coast Line has become highly profitable and is of the opinion that the construction of the new line will not seriously impair its earning capacity.

Work to Start Soon

The construction is ordered to be begun on or before September 1, 1926, and completed on or before June 30, 1928, and construction of the branch line shall be commenced before January 1929 and be completed before July 1930.

WASHINGTON NOTES

THE Chief of Engineers has reported to the Federal Power Commission that the project of the Twin City Power Co. on the Savannah River will not affect adversely the interests of navigation.

THE report of the joint engineering board which is making a study of dam sites and other features of the St. Lawrence project probably will be ready by Oct. 1, it was stated by Maj. Gen. Edgar Jadwin, the Chief of Engineers, on his return from the meeting of the Board at Valley Field, Canada. The entire session of the board was devoted to work on the report. Considerable progress has been made since the last meeting.

MAJOR Glen E. Edgerton, the chief engineer of the Federal Power Commission has been designated by the commission to represent it at the Triennial Congress of the Permanent International Association of Navigation Congresses, which is to meet in Cairo, Egypt, in December. As Major Edgerton is to be in Europe on other business at that time no expense to the commission will be incurred in this connection.

FINAL decision on requests for a modification of its policy opposing a bridge across San Francisco Bay north of Hunters Point, has been delayed indefinitely by the War Department at the request of the San Francisco and Alemeda County Bridge Commission and probably will not be rendered for thirty to sixty days. The bridge commission, a voluntary association of business and professional men, recently organized, asked delay in order that it might study the entire situation and try to bring all the various interests into an agreement for a definite project which might be placed before the War Department.

The Navy Department, however, has set its face firmly against any modification of the War Department policy adopted in October 1921, forbidding any bridge across the outer part of San Francisco Bay. After a hearing had been granted before the district engineer last December at the request of citizens interested in the new bridge project and who sought modification of the policy, and when the office of the Chief of Engineers was on the eve of compiling its final recommendation to the Secretary, the War Department asked the Navy Department its views. Secretary Wilbur replied to Secretary Davis, strongly recommending adherence to the policy of 1921, on the ground that a bridge might be destroyed in the event of war and bottle a fleet in the harbor, or in the event the fleet were outside, prevent it from entering. It was immediately following the announcement of the Navy's position that the San Francisco interests asked further delay by the Army engineers, which has been granted.

Further Extensions Granted in Railway Electrification

Four more railroads operating in and around New York City have received grants of extension of time in which to complete the electrification of their lines within the city. These are in addition to those noted in last week's issue p. 158.

The New York Central R.R. Co. has had the time for complete electrification of the main line of the Putnam Division and the Saw Mill River branch extended until Jan. 1, 1930, and of the Port Morris branch until July, 1927. Time for the electrification of the freight tracks on the west side of Manhattan Island as far south as 72nd St. has been extended to July 1, 1929, and for the tracks south of that point to July 1, 1930. The situation here is complicated by the crossing elimination work now in progress and the experimental use of Diesel-electric locomotives south of 72nd St.

The Long Island R.R. Co. has been given until 1931 to complete its extensive program which will require an expenditure of $13,000,000 and which must be carried on in connection with grade separation work requiring additional capital. An inadequate electric supply is also causing delay.

The Bush Terminal Co. has been given until 1931 to complete the electrification of its terminals in Brooklyn as it is conducting experiments in handling cars on and off of car floats by means of electric locomotives.

Application of the New York Dock Co. for an extension of time was denied on the ground that the company has made no effort to comply with the order.

East St. Louis Sewer Project Meets Opposition

Objections of property owners to the proposed Lansdowne sewer in East St. Louis, Ill., were sustained in a report submitted to the city commissioners by Harry Ferguson, chief sanitary engineer of the Illinois Department of Public Health who made a survey of the district and an examination of the plans recently. The project would cost $837,000. Mr. Ferguson concluded that the sewer would not provide satisfactory drainage facilities for all parts of Lansdowne, and that the present outlet as provided in the city's plans would overload the main city sewer, giving rise to unsanitary conditions. He further held that the plans do not take into consideration the future growth of the district.

Airplane Survey to Be Made of Missouri River Valley

Engineers of the War Department, assisted by Army air service men, will make an aerial survey of the Missouri River between St. Louis and Yankton, South Dakota, according to an announcement from the District Engineer's office at Kansas City. The survey will be used in connection with the proposed improvement of the Missouri River.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Providence, R. I., Sept. 14-17, 1926.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, Lawrence, Kansas; Annual Convention, Colorado Springs, Colo., Sept. 21-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

THE ASPHALT ASSOCIATION, New York City; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

The North Carolina Section, American Water Works Association, will hold its annual convention this year at Wilmington, N. C., Aug. 23-25.

Personal Notes

PAUL BAILEY, deputy state engineer of California, has been appointed state engineer to succeed the late W. F. McClure. Mr. Bailey is a native of California and a graduate of the University of California and Stanford University. From 1910 to 1916 he was in private engineering work with consulting engineering firms in California, largely employed in irrigation and land reclamation work. In 1916 he became engineer of the State Water Commission, which position he held until in 1920 he became water master for the Emergency Water Conservation Conference of the Sacramento Valley. Subsequently he was hydraulic engineer for the State Water Commission, then deputy chief, Division of Engineering & Irrigation, and deputy state engineer. In the latter position his work was largely in connection with irrigation and reclamation.

P. T. SIMONS, for the past nine years drainage engineer with the U. S. Department of Agriculture, has been appointed an assistant engineer in the office of the chief engineer, Missouri & Pacific R.R. Co., at St. Louis, Mo.

JOHN W. KENNEDY, formerly director of the Testing Laboratory of the Michigan State Highway Department, has been appointed engineer of the Service Bureau of the Huron Portland Cement Co., and the Wyandotte Portland Cement Co., with headquarters at Detroit, Mich. Mr. Kennedy is a graduate of the University of Michigan in the Class of 1921, served as instructor in the College of Engineering for a year, and then joined the Michigan State Highway Department as assistant director of the testing laboratories. Recently he has been studying under Professor Abrams at the Structural Materials Research Laboratory, Lewis Institute, Chicago.

FRANK I. GINSBERG, formerly with the Ginsberg-Penn Co., has become associated with the Melrose Contracting Co. of New York as vice-president and general manager. The latter firm is a consolidation of the Melrose Concrete Co. and the Dollan Contracting Co.

Obituary

COL. WASHINGTON A. ROEBLING, president of the John A. Roebling's Sons Co., died at Trenton, N. J., on July 21, in the 89th year of his age. An account of Col. Roebling's life will be given in next week's issue.

GEO. E. LADSHAW, consulting engineer, Spartanburg, S. C., died on July 22, age 76 years. Mr. Ladshaw was a native of Toronto, Ont., and located in Spartanburg in 1876, where, with his brother, Thomas E. Ladshaw, he formed the firm of Ladshaw & Ladshaw, civil and hydraulic engineers.

MARK A. WALDO, until recently a consulting engineer on bridge construction died at Bartow, Fla., on July 16. Mr. Waldo was a graduate of the University of Wisconsin in the class of 1884, spent a few years on railroad construction work while still a student and after graduation went into bridge construction work. The greater part of his active life was spent in this work and he served in various capacities on a number of important bridge construction jobs throughout the Central and Western states. In more recent years he served as a construction engineer for the Union Bridge Company and the Missouri Valley Bridge & Iron Works.

PETER STUPP, president of the Stupp Brothers Bridge & Iron Company, St. Louis, Mo., died in that city on July 16. Mr. Stupp was a native of St. Louis and at an early age entered business with his father. Subsequently he and his brother organized the present company which has been a pioneer in the fabrication of structural steel for bridges and buildings in the Middle West.

FRANK SUTTON, a geographer who has been a member of the technical staff of the U. S. Geological Survey since 1887, died at his home in Indiana, Pa., July 22, after an illness of two years. He was 67 years of age. During the war, he served in France with the 25th, 29th and 604th engineers.

F. A. SANFORD FOALE, architect and structural engineer, Sacramento, Cal., died in that city on July 7 following a nervous breakdown. Mr. Foale was 50 years of age at the time of his death. He was a native of Philadelphia, Pa., and received his technical education in the London Polytechnic Institute, London, England. He went to California to live about 20 years ago.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Steel Column Forms Assembled With Hammer and Nails

Built-up steel forms for square and rectangular reinforced concrete columns have been recently used on a number of large buildings in Washington, D. C. and their use is now being extended to other parts of the country. These forms, known as the Wells steel column forms, have been developed by the Washington Steel Form Co., Washington, D. C., with the claim that they are more economical than wood forms and at the same time are built and erected in exactly the same manner.

The forms are of pressed steel channels made of 14 and 16 gage Armco ingot iron in standard widths of 2 and 4 inches and lengths of 3, 4 and 5 feet. The web of each channel is reduced in width near the end for a distance of 12 in. so that the channels may overlap for connection purposes. A row of nail holes provides a means of adjusting the length of overlap. By virtue of the 2 and 4 inch widths the column sections can be reduced in size to suit the required dimensions of the respective columns at each floor as the structure progressed upward.

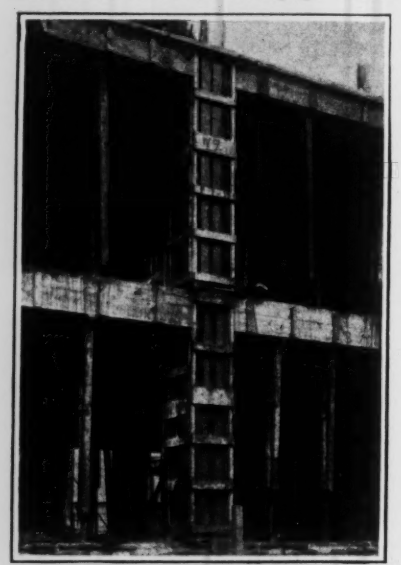


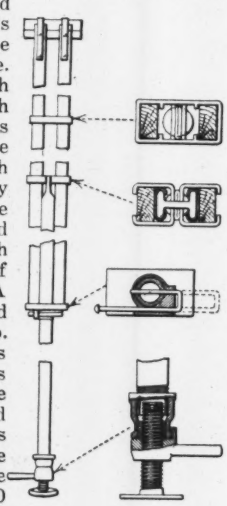
Fig. 1—Column form built up of steel channel sections

Fig. 2—Carpenters assemble forms with hammer and nails

The column forms are made up by carpenters using hammer and nails in the same manner as wooden columns are assembled. This therefore means that there is no radical change in the contractor's organization when he uses this type of form. There are no bolts, wedges or small parts to be lost. On a large apartment house in Washington the contractors say that the work of reducing and reassembling 208 columns per floor for each of the eight floors has been done by four carpenters working from the beginning of the job. The cost is said to have been about one-half what it would have been with wood forms.

New Adjustable Shore

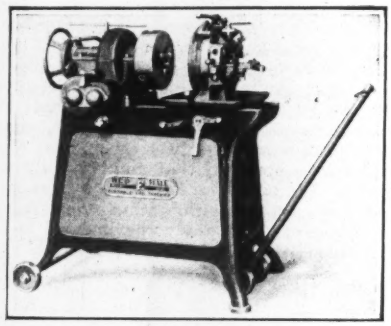
A new shore manufactured by the Dayton Sure Grip & Shore Co., Dayton, Ohio, is composed of 2x4 studs which telescope on 1½-in. pipe. The initial rough adjustment with a pin as well as the final hairline adjustment with an extra heavy screw jack on the bottom is claimed to do away with the possibility of creeping. A recommended load of 5,000 lb. for the shore is made, but it is stated they have been tested and used under loads of 10,000 lb. The shore complete weighs about 50 lb. and has a range from 8 ft. to 14 ft. Iron parts with the exception of the screw jack are made of specially treated malleable iron.



A New Portable Pipe Threader

Features of the new portable pipe threader, manufactured by Hall-Will, Inc., Erie, Pa., include the fact that it is made of malleable iron and steel, has three speeds, is driven by a silent-chain drive, is equipped with Timken roller bearings, and may be used as a power unit to drive hand stocks up to 8 in. Capacity for pipe is ¼ in. to 2 in. and for bolts ⅜ in. to 1½ in. The truck is built into the machine, the rear legs being mounted on small wheels, while the front are provided with double-swivel casters which elevate the front of the machine when the handle is moved forward. The trucks may be removed in 3 min. A 1-hp., 1,750-r.p.m. reversible motor is used with either push or turn button control. The gears are of chrome nickel steel. The oil pump is of the rotary type, driven direct from the motor, and being on a level with the reservoir is always primed.

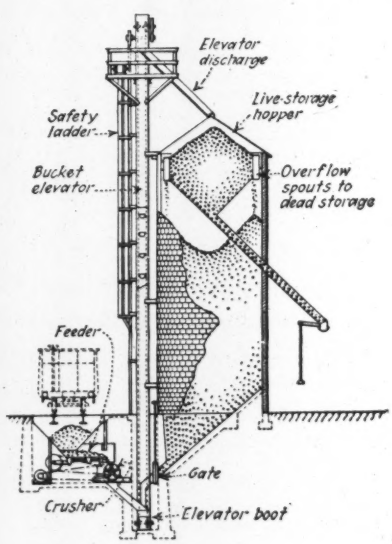
The cut-off attachment is of a new type, mounted on the front V block. The V blocks are operated by a handle on the rear side of the machine. The reamer and chamfer lever is mounted on the cut-off block.



The shortest length of pipe the machine will cut is 7 in. while it will thread close nipples. It occupies a space 38 x 26 in. on the floor and is 45 in. high overall. Its net weight is 450 lb.

Patent Tile Bin Incorporates Conveying System

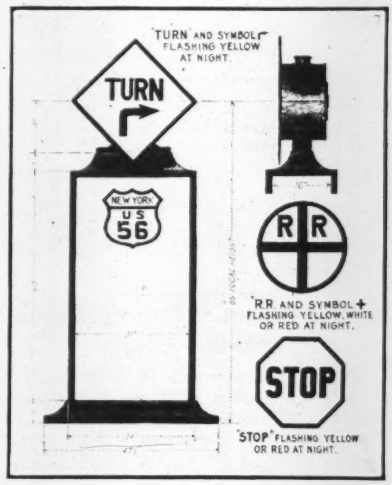
A silo shaped bin, divided for live and dead storage, was patented recently by the Stearns Conveyor Co., Cleveland, Ohio, and is now offered by it as a standard product. As at present generally constructed, the main circular upright structure is of hollow tile strengthened and reinforced with steel hoops. A steel plate cone, suspended at a suitable distance below the eaves, contains the live storage; it has a spout and gate to control the material discharge. When this live storage has been filled by the bucket elevator on the outside of the bin, the excess material overflows through pipes around the top of the cone into the reserve or dead



storage below. Thence it falls by gravity to the elevator boot, whence it is transferred as required to the live storage by the same elevator. It is to be noted that even should the elevator be left running after the live storage is filled, no damage can be done. It is pointed out that since the bin is placed outside of the building to which it feeds its material, it is often possible to reduce the cost of the building itself on account of the lower height required.

New Highway Signals for Both Day and Night Service

The new highway signal manufactured by the Interflash Signal Corp., 120 Broadway, New York City, is designed for both day and night service, as all parts of the words and symbols are illuminated at night by a flashing light. The signal is built in conformity with the standards adopted and approved by the recent Conference on Street and Highway Safety. The pedestal of the signal is constructed of iron enameled white and set in a black enameled frame. The base is 47½ in.



by 32½ in., while the focal height from base to center of the sign is 85 in. The direction sign can thus be easily placed upon it. The flashing signals are made of brass and aluminum, painted yellow with the words and symbols of glass. These flash either yellow or red at night. The flashing mechanism consists of flasher, patented thermo-siphon, gage, regulator and Prest-O-Lite acetylene tank.

Zone Painting Machine Makes Straight Edged Lines

The all-aluminum zone painting machine, manufactured by the Continental Products Co., Euclid, Ohio is claimed to utilize a principle which insures absolutely straight edged lines. The machine will operate on curves or angles of any sort. No brushes or spray guns are used on the machine. It consists merely of an aluminum wheel revolving in the paint tank as the machine moves. This feed wheel lays the paint evenly on an endless soft rubber belt which carries it down and applies it to the pavement. A perfect application of the paint is claimed to be obtained by traction pressure of the soft rubber belt as it comes in contact with the pavement. This is claimed to

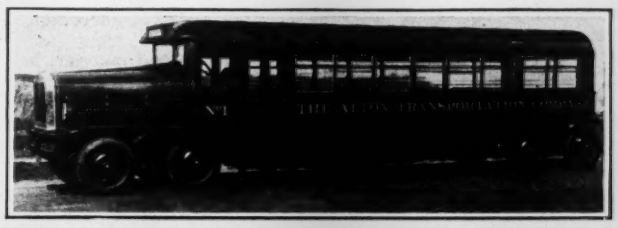
make a much more lasting line than with many other processes. The machine weighs 200 lbs. and is, therefore, easily transported.

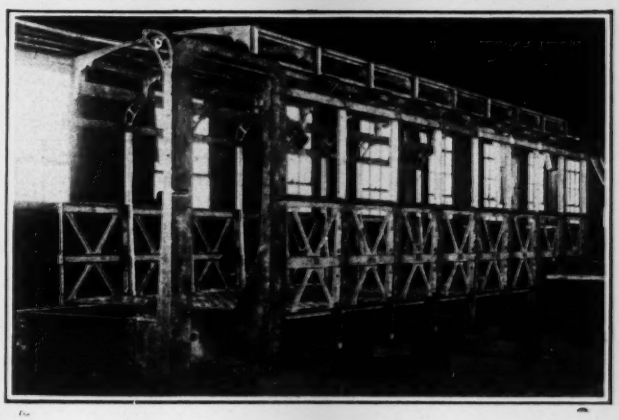
Gas-Electric Motor Bus Uses Aluminum Construction

The collaboration of the Versare Corp., Albany, N. Y., Westinghouse Electric & Manufacturing Co. East Pittsburgh, Pa., and the Aluminum Co. of America has produced two new motor buses embodying several unique features. In the first place the machines are of the gas-electric type. Then both the front and rear trucks are controlled by an articulated steering device which permits the driver to turn the 36-ft. bus in a 40-ft. highway. Finally, the coaches are constructed of aluminum and aluminum alloys which permitted them to be built in an exceptionally large size. They were built especially for the Chicago and Alton Railroad to operate between Jacksonville, Ill. and St. Louis, Mo., a distance of 94 miles.

The coach body itself is a truss; in the ordinary sense there is no chassis. This truss arrangement can be seen in one of the accompanying illustrations. The body is mounted upon two four-wheel trucks as shown. The motive power is furnished by a 120-hp. Waukesha, gasoline engine connected with 40-kw. Westinghouse generator.. This furnishes current to operate the 28-hp. 175 volt motor mounted on each of the trucks. Westinghouse air brakes are used. The interior of the coach has a height of 6½ ft. and an equalized spring suspension eliminates the jarring effects of all ordinary ruts.

Special aluminum alloys are used in the coach, the high stressed castings being made of a special alloy known as No. 195 and the non-stressed castings being made of a silicon alloy. The more important structural members of the coach are of duralumin, while the sheeting which encloses the coach is of pure aluminum.



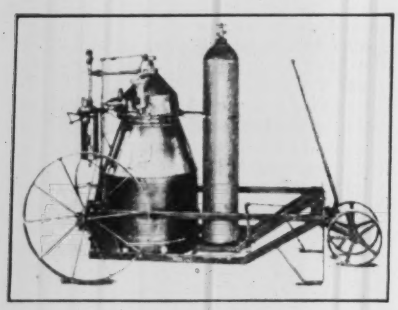


Tests Indicate Safety of New Acetylene Generator

The new portable acetylene generator manufactured by The Bastian-Blessing Co., has recently been approved by the Underwriters' Laboratories, after a series of exacting tests. Stability was shown by two tests. In the first, one wheel of the generator was raised 21 in. without the fully charged generator tipping over sideways. In the other, the front of the truck was raised 66 in. without the generator tipping over backwards. Next, the generator was set to producing gas at 10-lb. pressure and thrown on its side. All of the gas and water was expelled through the blow-off valves without any damage being done. In the final test, the generator carbide feed was locked and the generator thrown on its side. The pressure did not build up inside the generator and upon being returned to an upright position the entire charge of carbide was run through successfully.

It is said that the generator produces acetylene for approximately 1½ cents a foot, and the claim is made that if a shop uses only one 300-ft. tank of acetylene a week, the saving in the cost of acetylene

will pay for a 30-lb. generator in less than six months. The generators are made in two sizes, 30 lb. carbide capacity and 60 lb. carbide capacity. Most sizes use ¼ in. by ½ in. carbide. The smaller generator can safely de-



liver up to 60 cu.ft. per hour for short periods when necessary while the larger has a maximum delivery of 120 cu.ft. per hour.

Business Notes

TRIUMPH ELECTRIC CORP., Cincinnati, Ohio, has been organized to take over the goodwill, patent rights and inventions of the Triumph Electric Co. So far as practicable, the new company will retain the old personnel, and will specialize on its self-start automatic heavy duty motor, and at the same time be in a position to supply its other lines with electrical and refrigerating products.

DEAN HILL PUMP CO., Anderson, Indiana, announces the opening of a Philadelphia office in the Real Estate Trust Building, with R. W. Nagle as manager.

C. W. FISHER, for the past two years associated with the McMyler-Interstate Co., Cleveland, in the sales engineering department, has been named the head of the Chicago branch of the firm. His territory includes the Upper Mississippi district, including Illinois, Indiana, Wisconsin and parts of Minnesota and Nebraska.

New Publications

Cranes—ORTON CRANE & SHOVEL CO., Chicago, devotes a new 23-page bulletin No. 41 to its models "T" and "E" convertible gasoline-steam-electric cranes. Besides illustrating and describing the various details and giving drawings and tables of the working dimensions and specifications, the booklet contains a great many illustrations of the cranes at work.

Diesel Lubrication—TEXAS CO., New York City, in its monthly publication "Lubrication" for June, 1926, discusses at length the subject of large Diesel engines and their lubrication. This issue is well worth while as a reference and guide for all Diesel engine owners and operators.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
July 29, 1926	$16,459,000	$35,708,000	$52,167,000
July 22, 1926	20,694,000	26,089,000	46,783,000
July 30, 1925	19,352,000	19,036,000	38,388,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	630,657,000	1,031,,479,000	1,662,136,000
1925	605,679,000	745,189,000	1,350,868,000

Cement Movement Shows Record Volume During Second Quarter

Portland cement is not only following its regular seasonal variations in demand but the whole movement (production, shipments and mill stocks) is measurably heavier than a year ago.

At the close of the first quarter, this year, doubt was expressed as to the continuation of the 1922-26 high level of construction volume, when cement statistics for that period were released.

Comparing the first quarter of 1926 with the corresponding period last year, production was found to have dropped over 7 per cent, shipments nearly 2 per cent and reserve stocks at mills throughout the country to have increased 15 per cent.

Returns for the second quarter, however, show the situation reversed. Mill reserves are still comparatively heavy but shipments were 3 per cent and production, 2 per cent greater than during the period Apr. 1 to July 1, 1925.

Production

	1925 Barrels	1926 Barrels
Jan	8,856,000	7,887,000
Feb	8,255,000	7,731,000
Mar	11,034,000	10,355,000
1st quarter	28,145,000	25,973,000
Apr	13,807,000	12,401,000
May	15,503,000	16,472,000
June	15,387,000	16,827,000
2nd quarter	44,697,000	45,700,000

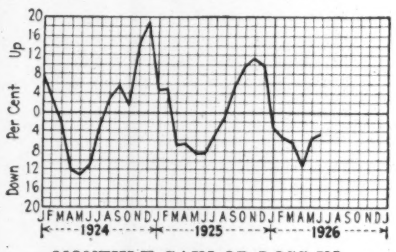
Shipments

	1925 Barrels	1926 Barrels
Jan	5,162,000	5,672,000
Feb	6,015,000	5,820,000
Mar	10,279,000	9,539,000
1st quarter	21,456,000	21,031,000
Apr	14,394,000	12,961,000
May	16,735,000	17,951,000
June	17,501,000	19,013,000
2nd quarter	48,630,000	49,925,000

With demand substantially ahead of the output and both gaining, the seasonal decline in mill stocks will serve to make prices firmer but probably not higher. There were 18,987,000 bbl. on hand at mills throughout the country, July 1, 1926, as against 21,173,000 on June 1 and 16,409,000 bbl. on July 1, 1925. These statistics are according to the Bureau of Mines, U. S. Department of Commerce.

Steel Demand Following Regular Seasonal Course

That steel demand is following its regular seasonal course, adhered to since early in 1924, is shown by the accompanying diagram. This chart shows the per cent gain or loss, from month to month, in unfilled orders on books of the U. S. Steel Corporation, as of the last day in each month.



MONTHLY GAIN OR LOSS IN FORWARD ORDERS

The seasonal up-swing in demand for the year 1924 began in August, that for 1925, in September; from present indications it will not occur this year, earlier than September.

UNFILLED STEEL TONNAGE ON LAST DAY OF EACH MONTH

	1924	1925	1926
Jan	4,798,429	5,037,323	4,882,739
Feb	4,912,901	5,284,771	4,616,822
Mar	4,782,807	4,863,564	4,379,935
Apr	4,208,447	4,446,568	3,867,976
May	3,628,089	4,049,800	3,649,250
June	3,262,505	3,710,468	3,478,642

Eleven States Have Over Ten Motor Vehicles Per Mile of Public Road

Gradual Increase In Volume of Street and Road Contract Letting Compared with Abrupt Gain in Registrations

THE abrupt gains in motor registrations from year to year, during the past twelve years, as compared with the very gradual increase in volume of street and road construction, is illustrated by Fig. 1.

In this chart the money value of street and road contracts awarded throughout the entire country, 1913 to 1925, inclusive, is from the Construction News Section of *Engineering News-Record*. The curve showing actual physical volume of street and road building is obtained by dividing the money value index (per cent of 1913) by the *E. N.-R.* Construction Cost Index Number for each year. This process eliminates all price inflation which occurred during the twelve-year period and places the contract totals on a 1913 cost basis or as though no price changes had taken place since then. Registration and mileage figures are derived from statistics of the Bureau of Public Roads, U. S. Department of Agriculture.

The number of motor vehicles per mile, in each state, is arrived at by dividing the total registrations by the public road mileage. These are shown in Fig. 4.

It will be noted in the illustration just mentioned, that eleven states have over ten motor vehicles per mile of public road. Only six of these states (see Fig. 3) have had heavy road building programs during the last year, they are: New York, Pennsylvania, Ohio, Illinois, Texas and California. Four others, namely, Massachusetts, New Jersey, Maryland, and Michigan, were only moderately heavy in money value of street and road contracts let, while Rhode Island and Connecticut were extremely light. Texas occupied a singular position in that it had an extensive road building program with registrations indicating less than six motor vehicles per mile of public road.

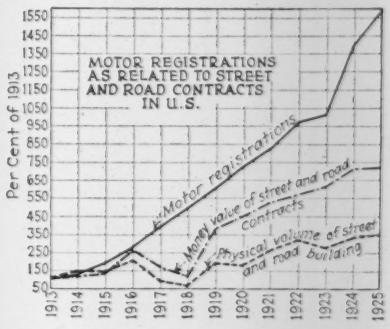


Fig. 1—Abrupt Gain in Number of Vehicles compared with Very Gradual Increase in Road Building

(*Continued on p. 202.*)

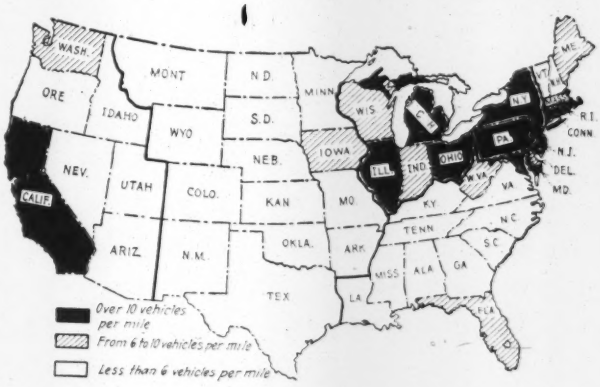


FIG. 2—WHERE MOTOR VEHICLES REACH GREATEST NUMBER PER MILE OF PUBLIC ROADS

FIG. 3—WHERE 1925 CONTRACTS AWARDED FOR STREET AND ROAD CONSTRUCTION REACHED HIGHEST MONEY VALUE

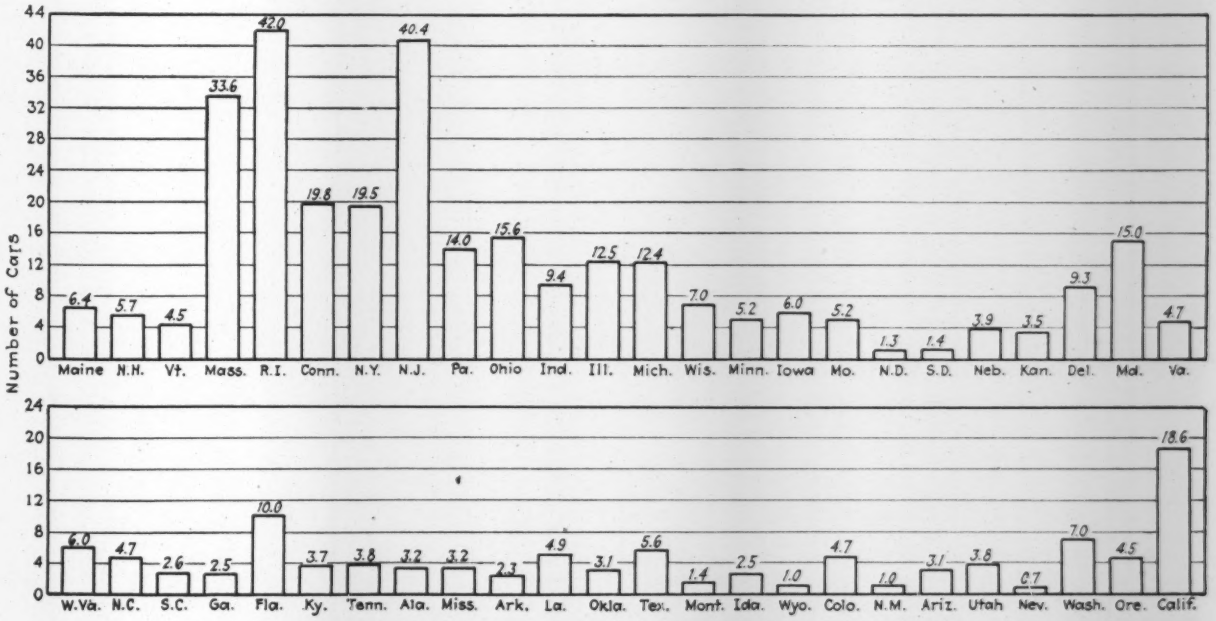


FIG. 4—NUMBER OF MOTOR VEHICLES PER MILE OF PUBLIC ROADS

Weekly Construction Market

DECLINING tendencies are apparent in prices of several of the principal construction materials, namely, sand, gravel, lime, and lumber. In the last mentioned, the depression affects mainly 1-in. pine boards, finish, flooring and siding, lath, two-by-fours and red cedar shingles. Current steel demand is particularly active and runs largely to structurals, pipe, bars and railway material. Plates and nails appear slower, although there is no perceptible easing of prices in any of the steel items except rivets and boiler flanges. Structural rivets dropped 30c., to $4.20 per 100 lb., at New York warehouses, during the last two weeks. This figure applies on deliveries to site of job in less-than-carload quantities. Pig iron and coke hold at last week's levels; scrap is weaker. The principal hot-rolled steel products are $1.90 per 100 lb., Pittsburgh mill, in carload lots or over; $2 applies on bars and shapes in smaller tonnages. Wrought-steel pipe discounts were lowered four points at Chicago warehouses during the last month. Linseed oil prices tend downward.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	$4.00
Structural rivets, 100 lb	—4.20	3.80@5.00	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	3.38	2.60	2.87½	3.77½	2.95	3.25	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	53.6%	+51%	54.25%	36%	35.6@49.2%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	51.60@53.60	47.50	54.00	49.20@50.20	53.00	64.00	50.00	55.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.60	1.65	1.90	1.80	1.50	1.50
Sand, cu.yd	1.00	1.60	2.00	1.40	1.25	1.00	1.40	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.85	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	1.70
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	62.00	34.00	56.00	40.50	—38.25@38.50	34.75	27.00	23.00	55.00
Lime, finishing, hydrated, ton	18.20	23.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.85	2.25	1.60@1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	—9@10	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.075	.076	.075	.....	.09	.12
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.075	.076	.075	.108	.09	10
Linseed oil, raw, 5 bbl. lots, gal	.94½	.96	1.13	—.95	—1.02	1.14	.97	1.12	1.03
Common Labor									
Common labor, union, hour	.90⅜	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	82½	.45@.60	40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.
Labor—Concrete laborers' rate, 93⅜c.; building laborers, 90⅜c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of July 1 the next on Aug. 5.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, f.o.b. in carload lots.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.15). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, less-than-carload lots.

Eleven States Have Over 10 Motor Vehicles Per Mi. of Road

(*Concluded from p. 201*)

Eight states, namely, Maine, Delaware, West Virginia, Florida, Indiana, Wisconsin, Iowa and Washington, have from six to ten motor vehicles per mile of public road. Maine and Delaware each had less than one per cent of the nation's total of street and road lettings, while the other six ran from one to 5 per cent, or fairly light.

A volume of street and road construction sufficiently high to indicate that the state is well in advance of the gain in motor traffic is noted in the following: North Carolina, Tennessee, Mississippi, Alabama, Louisiana, Missouri, Minnesota, Texas, Oklahoma, Kansas, Nebraska and Oregon.

Comparatively light road lettings and equally light motor registrations are noted in Vermont, New Hampshire, Virginia, South Carolina, Georgia, Kentucky, Arkansas, South Dakota, North Dakota, Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Arizona and Nevada.

No attempt is made here to say just how much money should be spent in contracts or how many miles of road should be maintained, per motor vehicle.

From the figures submitted, however, it is possible to judge which states are in greatest danger of serious motor traffic congestion. This is shown graphically in Figs. 2, 3 and 4.